



Universidade de Évora
Honesto Estudo com Longa Experiência Misturado

GEOMÁTICA

DESENHO TÉCNICO ASSISTIDO POR COMPUTADOR

Caderno de exercícios
(Edição revista)

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Textos didáticos

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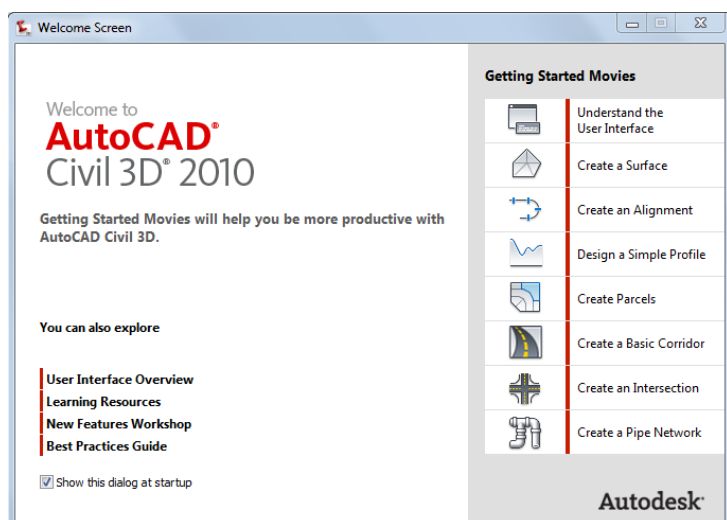
I – Introdução ao AutoCAD

Capacidades a adquirir nesta aula:

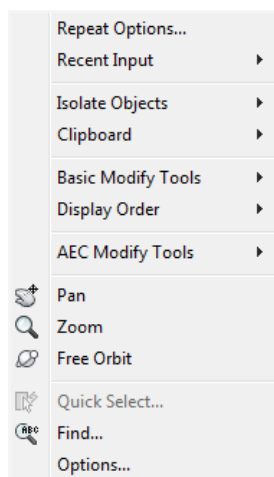
- a) Compreender o sistema de coordenadas absolutas e relativas em AutoCAD;
- b) Desenhar figuras geométricas simples, selecionar o tipo de letra;
- c) Saber editar as figuras, utilizando COPY, ERASE e MOVE;
- d) Saber utilizar as ferramentas de apoio OSNAP, SNAP, GRID, ORTHO, ZOOM;
- e) Saber gravar e recuperar os desenhos;
- f) Saber utilizar adequadamente os tipos e espessuras de linhas;
- g) Desenhar figuras geométricas mais complexas, incluindo elipses, polígonos e arcos;
- h) Utilizar ferramentas de produtividade tais como ROTATE, OFFSET e MIRROR;
- i) Saber editar as peças utilizando EXTEND e TRIM.

1. Sequência de passos na abertura do AutoCAD

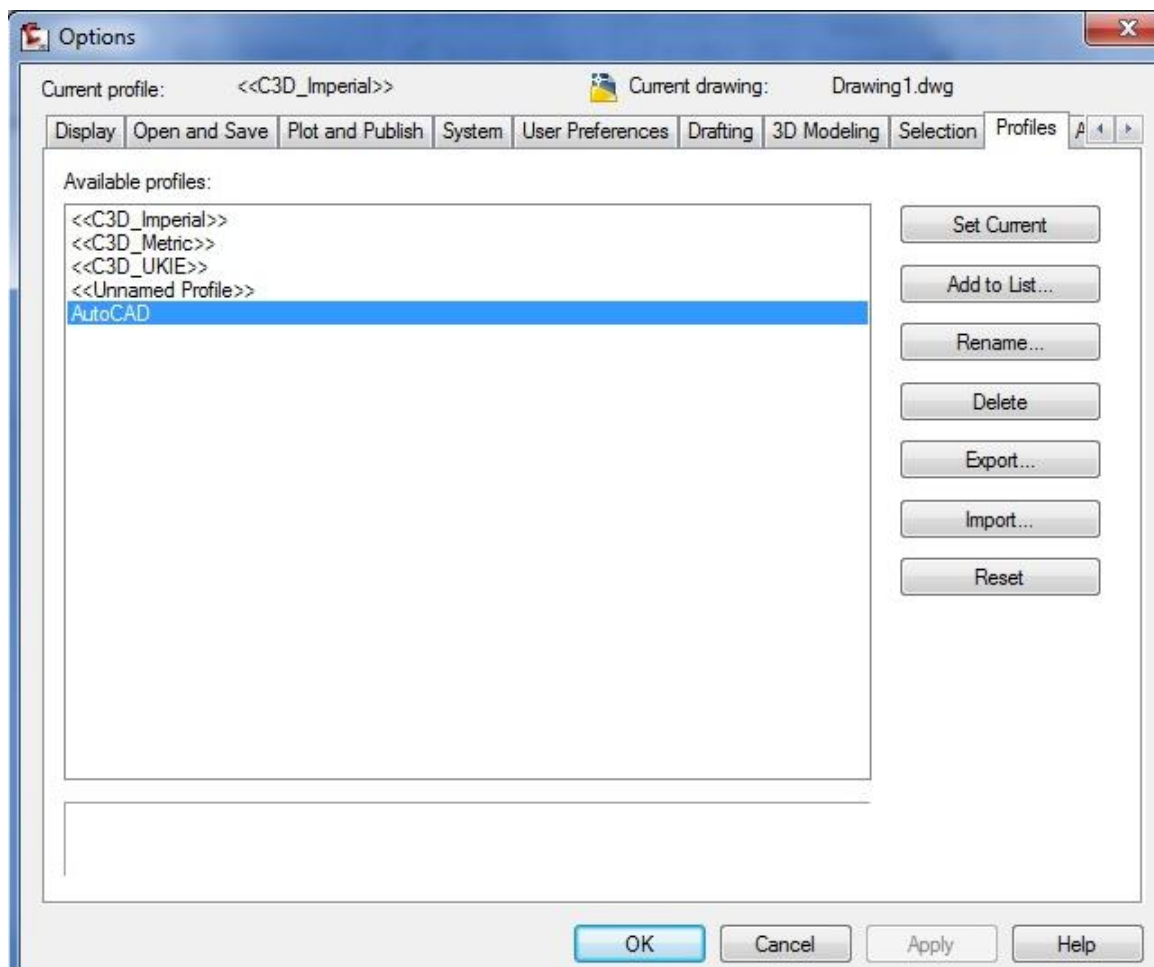
1.1 Janela Welcome screen – fechar.




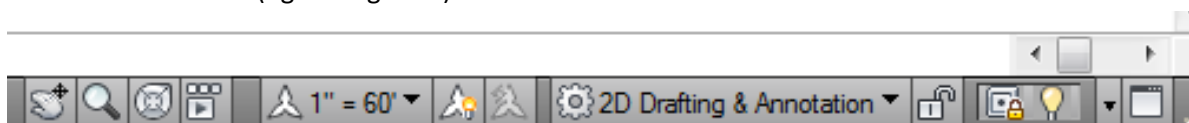
1.2 Clicar botão direito do rato e na janela abaixo selecionar “Options”.



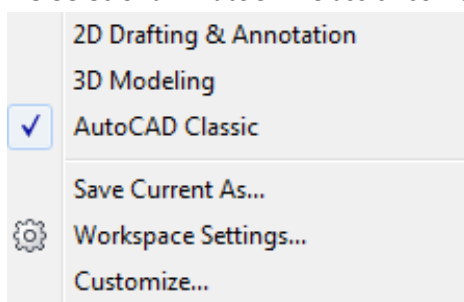
1.3 Na janela abaixo indicada selecionar “AutoCAD” e depois “Set Current” e “OK”



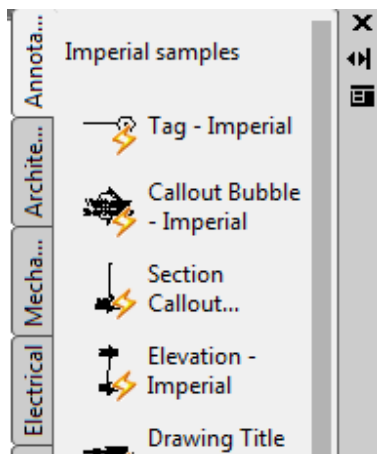
1.4 Na barra inferior (figura seguinte) clicar no ícone .



1.5 Selecionar “AutoCAD Classic” como mostra a janela a seguir indicada.

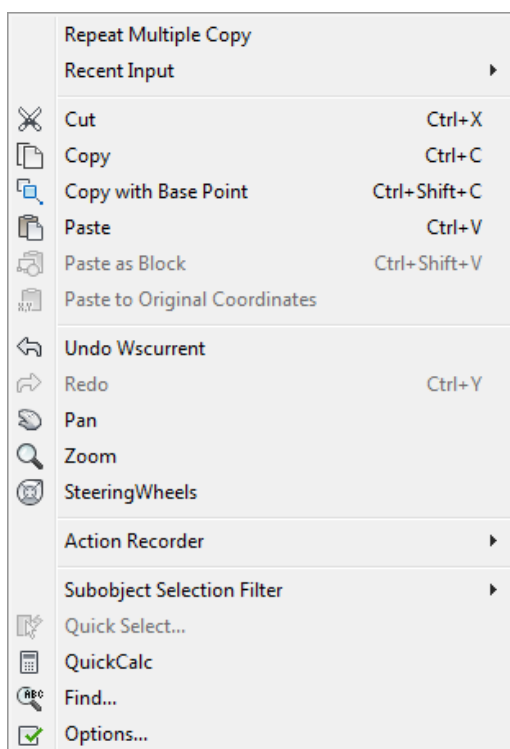


1.6 Fechar a janela

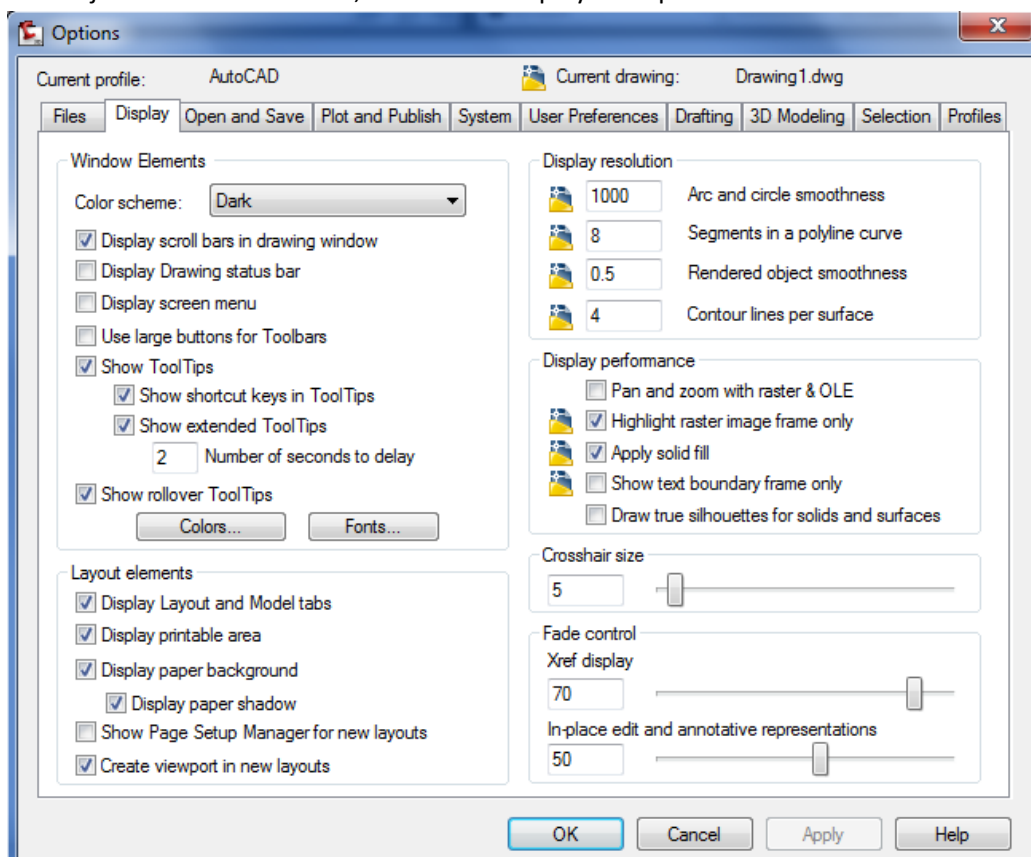


1.7 Alterar o fundo do ecrã

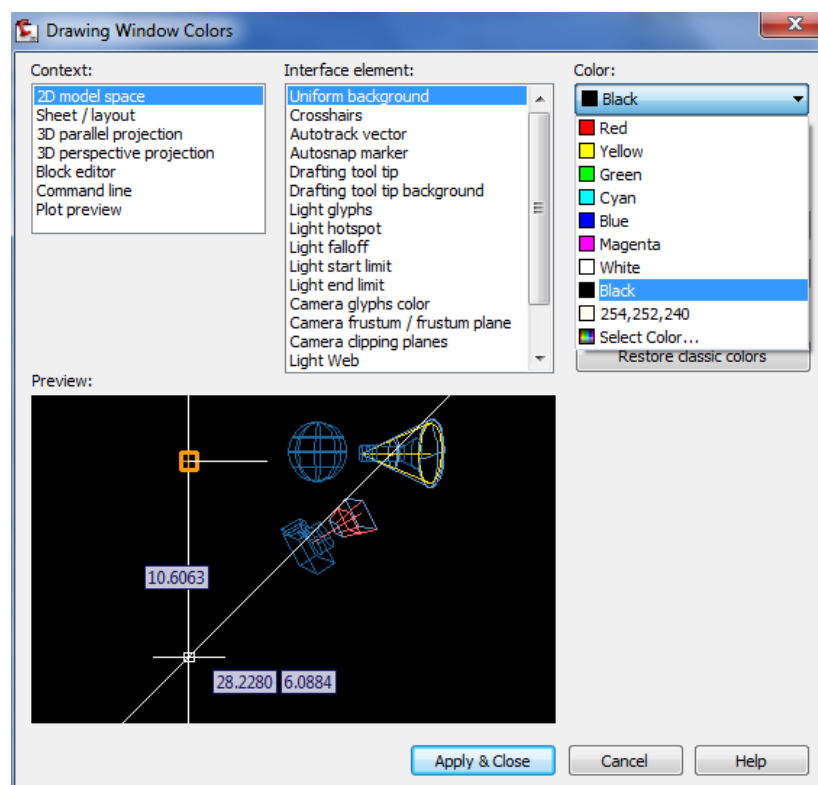
Clicar no botão direito do rato e na janela abaixo indicada, seleccionar “Options”.



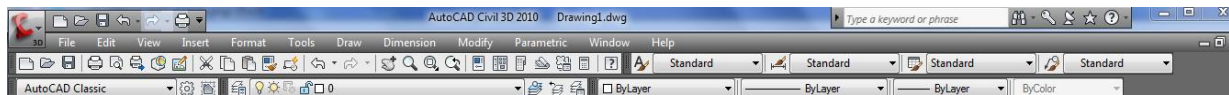
1.8 Na janela abaixo indicada, selecionar “Display” e depois “Colors”.



1.9 Na janela “Drawing Window Colors” selecionar a cor pretendida no menu “Color”, depois “Apply and Close”.



1.10 A barra de ferramentas do “AutoCad Classic” tem o aspeto indicado em baixo.



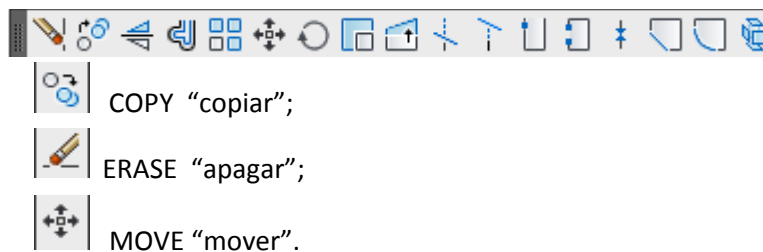
2. Comandos de desenho

Procure familiarizar-se com estes comandos:

TOOLBAR Draw



TOOLBAR MODIFY



3. Comandos de ampliação

Estes comandos permitem definir a ampliação com que se pode ver a figura no ecrã.

TOOLBAR DISPLAY CONTROL

Zoom



pan / zoom dynamic/ zoom/ zoom previous



4. Localização das coordenadas no ecrã

No fundo da página estão as coordenadas do cursor. Sistema de Coordenadas Absolutas: (X, Y, Z)

-5256.318, 4694.514, 0.000

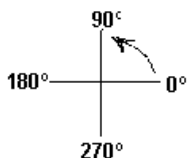
5. Coordenadas relativas

@ Permite introduzir coordenadas relativas.

```
Command:
Command: _line Specify first point:
Specify next point or [Undo]: @5,30,0
```

5.1 (@ X, Y, Z)

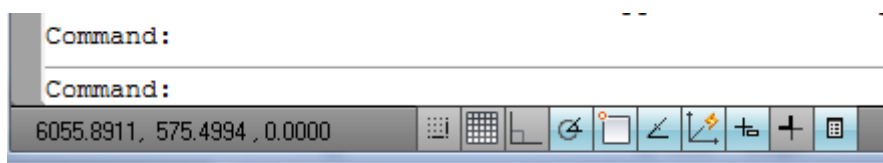
5.2 (@ d < θ) d=distância e θ o ângulo



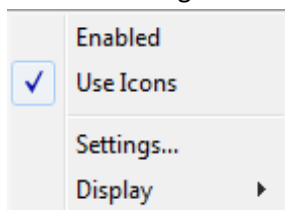
```
Command:
Command: _line Specify first point:
Specify next point or [Undo]: @5<45
```

6. Ajudas de desenho do AutoCAD

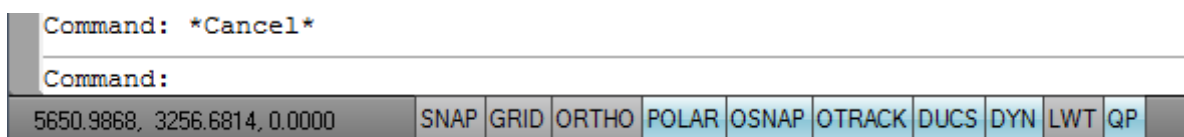
6.1 Na barra de ferramentas inferior surgem diversos ícones como se pode verificar na figura seguinte.



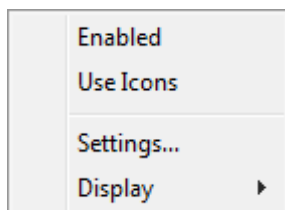
6.2 Com o cursor em cima de um ícone, clique no botão do lado direito do rato e surge a janela que se mostra a seguir.



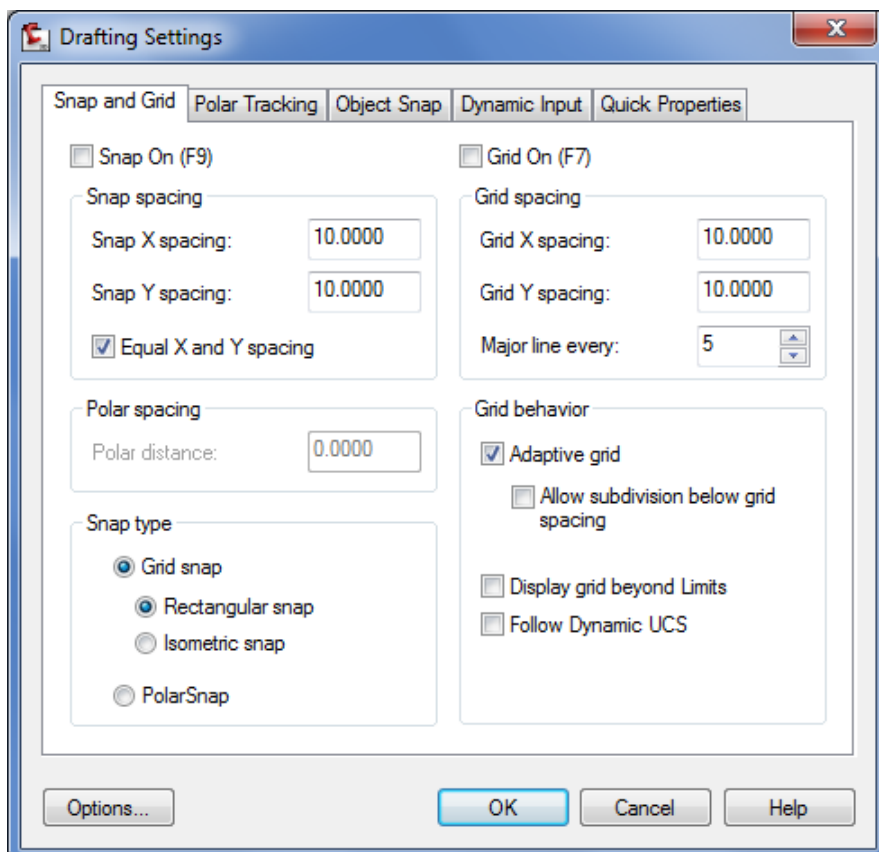
6.3 Ao desativar "Use Icons", estes tomam o aspeto que se mostra em baixo.



6.4 Em seguida, novamente com o cursor em cima de um ícone, clique no botão do lado direito do rato e surge a janela que se mostra a seguir.



Clique em "Settings" e surge a janela "Drafting Settings".



6.5 Selecione “Snap and Grid”, e defina o “Grid spacing” e o “Snap spacing” com o mesmo valor, tal como se mostra na figura anterior.

6.6 Ativar ícones de ajuda

No fundo da página encontra os ícones a seguir indicados,



onde:

SNAP: “agarrar” (F9)

GRID: “grelha” (F7)

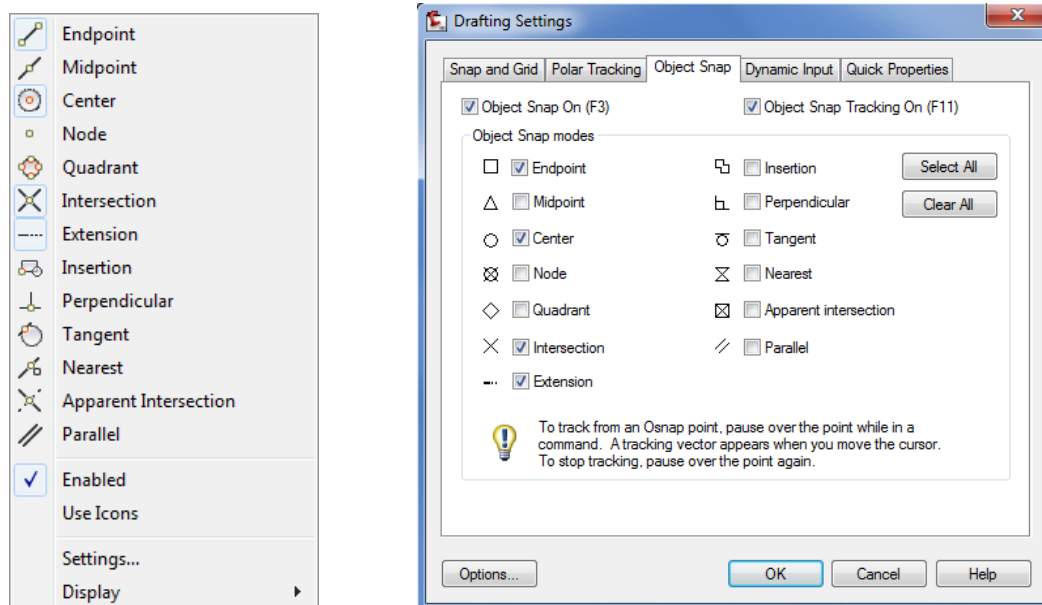
ORTHO: “ortogonal” (F8)OSNAP: “agarrar pontos definidos”.

6.7 Definir os pontos onde agarra

Clicar com o botão direito do rato em “OSNAP”, e do lado esquerdo do monitor surge a janela indicada à esquerda, na página seguinte.

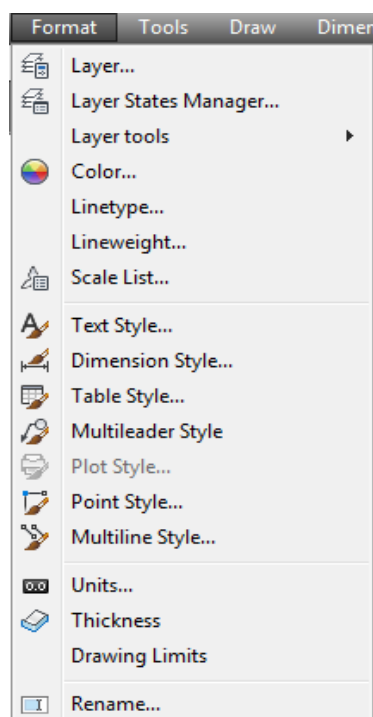
Clicar em “Settings” e do lado direito do monitor surge a janela “Drafting Settings” – página seguinte.

Ao seleccionar “Object Snap”, pode definir o tipo de pontos que pretende agarrar.



7. Definição dos limites do desenho, o tipo da linha e espessura de linha

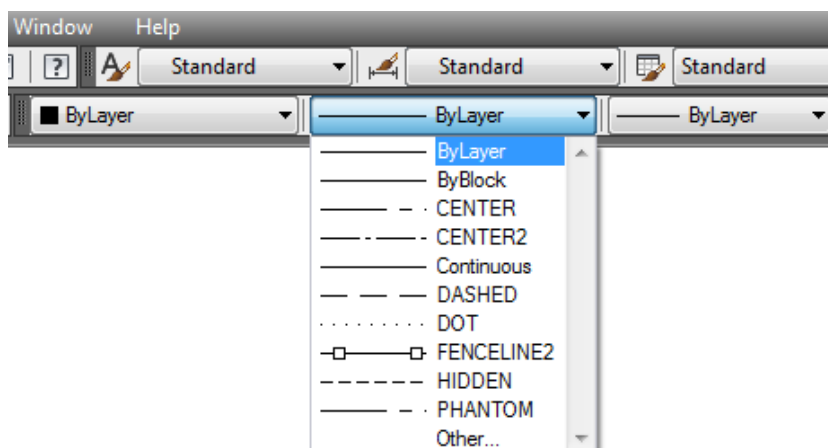
7.1 Definir a dimensão da grelha



Selecionar "Drawing limits".

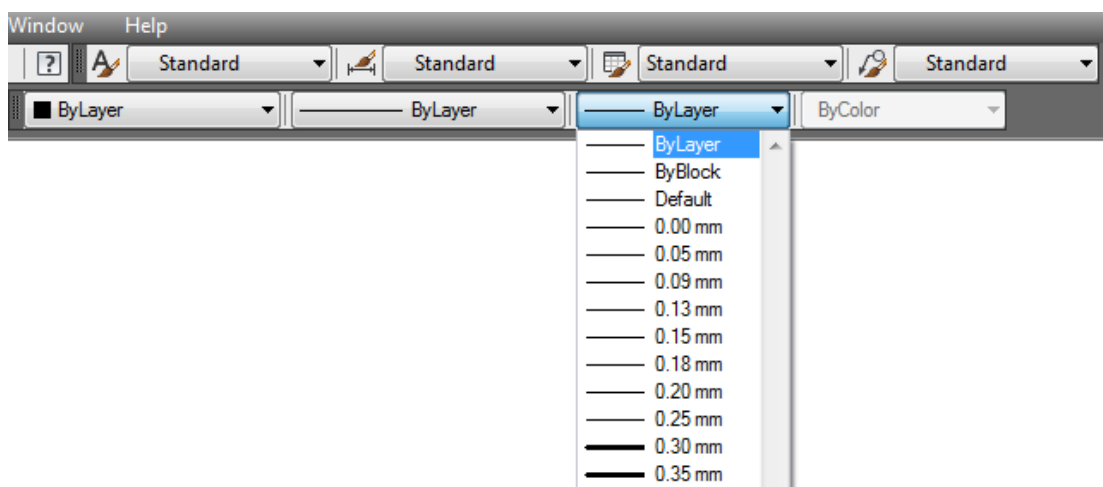
7.2 Definir o tipo de linha

Na barra de ferramentas superior, ao seleccionar o ícone "ByLayer" colocado na posição central, como mostra a figura da página seguinte, é possível definir diferentes tipos de linha.



7.3 Definir a espessura de linha

Ainda na barra de ferramentas superior, ao seleccionar o ícone “ByLayer” colocado à direita (figura seguinte), pode escolher a espessura de linha, devendo em seguida clicar no ícone **LWT** situado na barra de ferramentas da base da página.



7.4 Ícones importantes



Novo;



Abrir,



Gravar.

8. Definição de layer

Possibilita a construção de desenhos em níveis diferentes, podendo estar ou não visíveis.

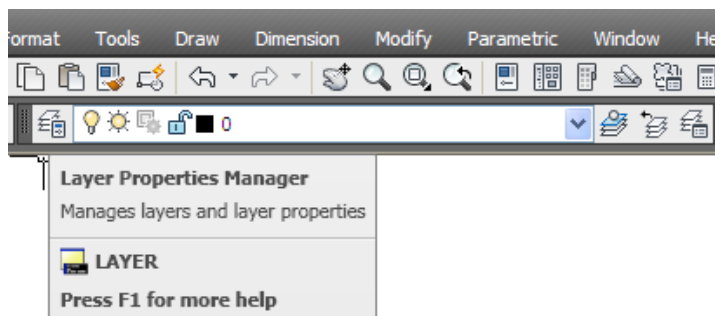


LAYER

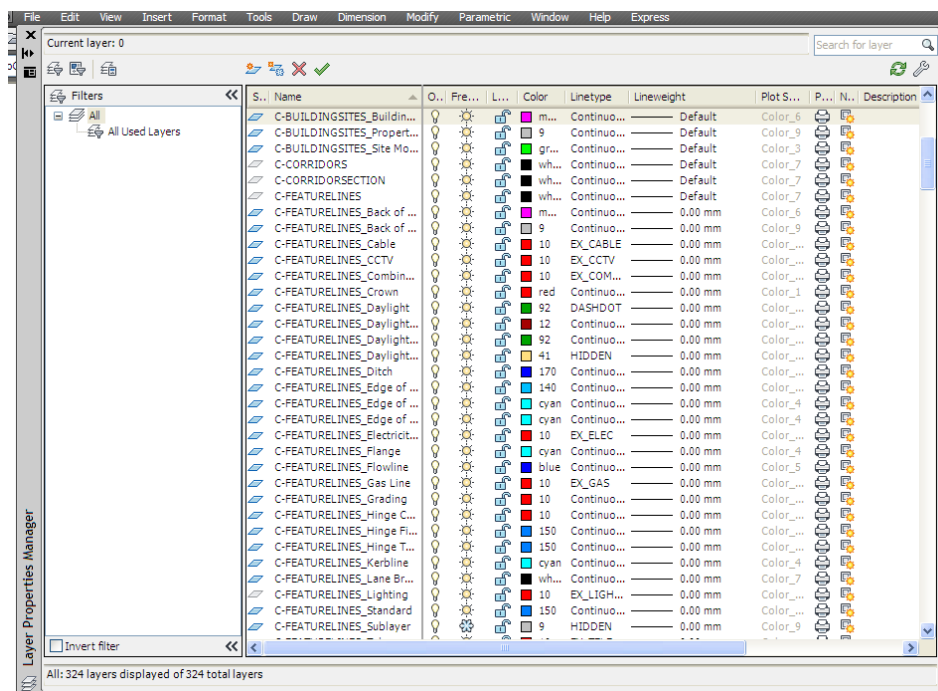
8.1 Definição do tipo da linha, da espessura da linha e da cor com a criação de uma layer

Os desenhos são feitos numa ou em várias camadas (“layers”) que se devem formatar quando se criam.

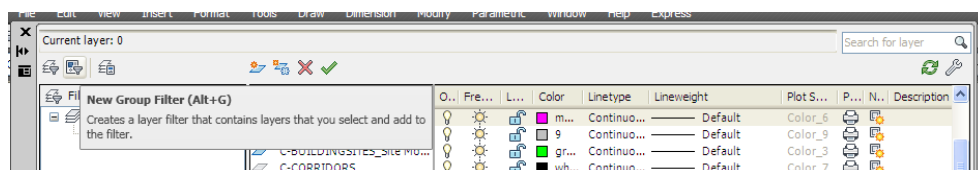
Para criar uma nova camada selecione a instrução “Layers Properties Manager” na barra de ferramentas “Layers”. Surge uma janela com todas as camadas predefinidas pelo sistema.



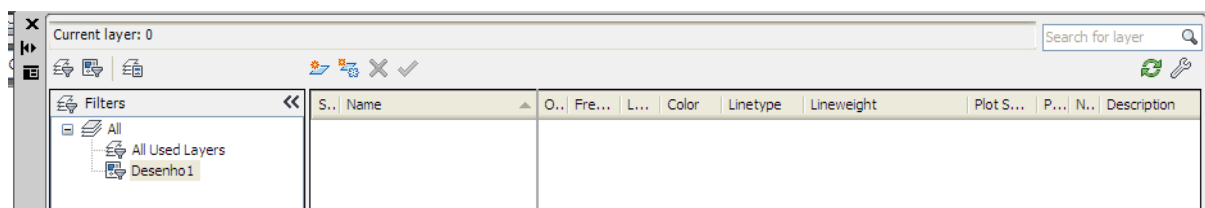
As camadas que se encontram predefinidas podem ser mantidas ou apagadas. Para as apagar deve seleccioná-las, clicar na tecla direita do rato e pressionar a instrução delete.



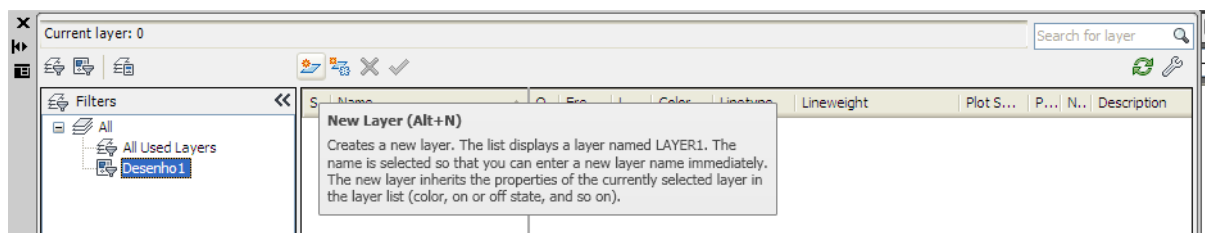
Para criar um novo grupo de camadas selecione a instrução “New Group Filter” que se encontra:



Surge um novo grupo a que deve dar um nome

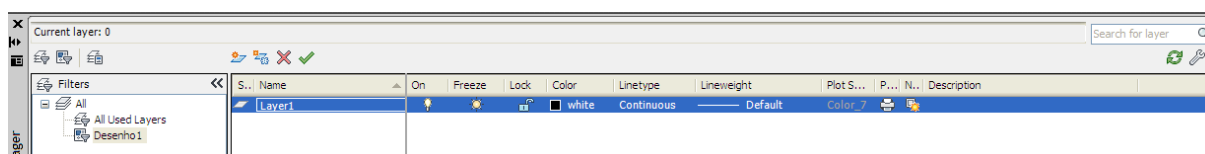


Selecione o grupo que acabou de criar e clique em “New Layer” para adicionar uma nova camada.
























Surge do lado direito a nova camada com as definições por defeito, a que deve dar um nome e formatar a cor, o tipo e a espessura da linha.

Para as alterar basta clicar duas vezes em cima da cor, do tipo ou da espessura da linha predefinida e seleccionar na janela que aparece a que desejar utilizar.

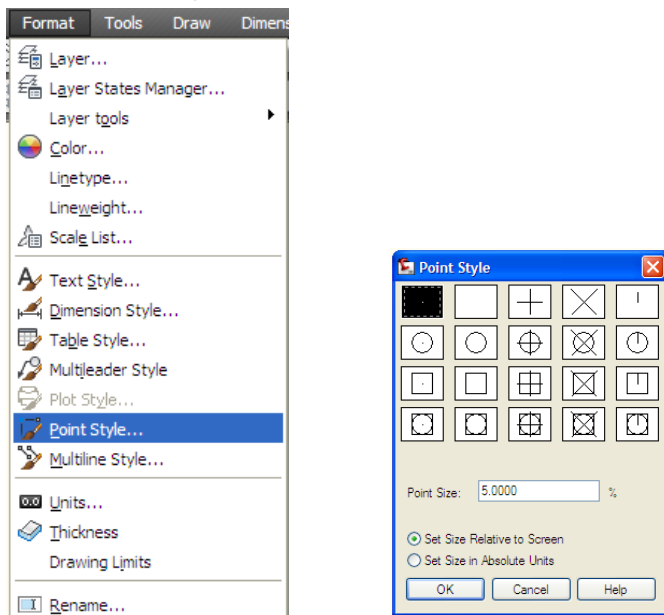


9. Procure familiarizar-se com estes comandos

TOOLBAR DRAW		TOOLBAR MODIFY	
	Line		Erase
	Construction line		Copy
	Polyline		Mirror
	Polygon		Offset
	Rectangle		Array
	Arc		Move
	Circle		Rotate
	Ellipse		Trim
	Point		Scale
	Text		Fillet
			Explode

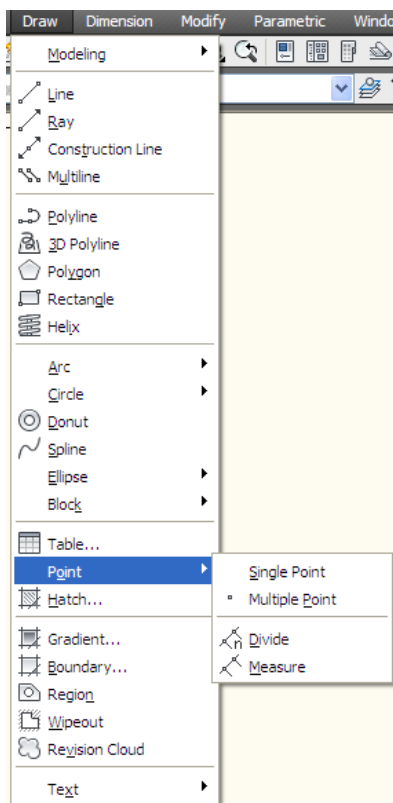
10. Definição do estilo do ponto

Menu **FORMAT / POINT STYLE**



11. Divisão de um objeto num qualquer número de peças

Pode dividir-se um objeto num qualquer número de peças iguais ou dividir em bocados com uma medida predefinida com as ferramentas do Menu **DRAW / POINT**

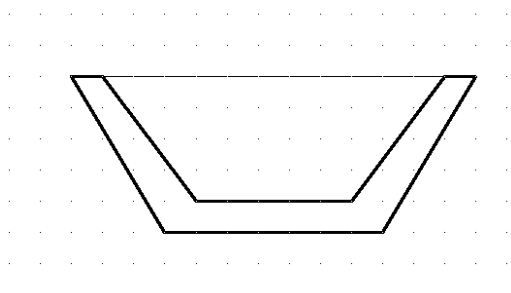


“divide”

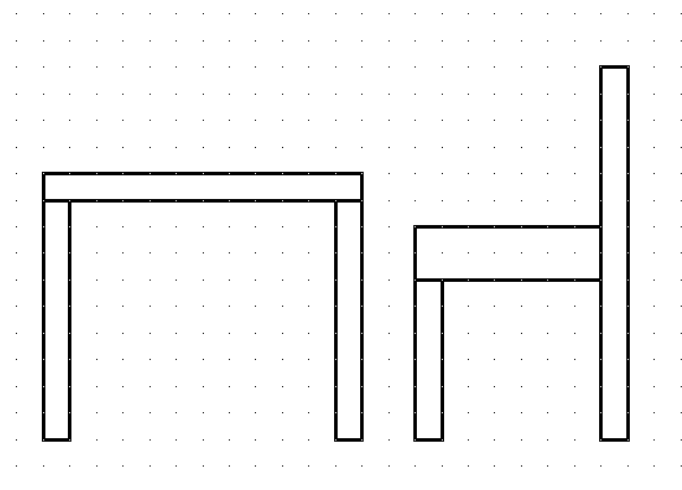
12. Ensino presencial

12.1. Desenhe as seguintes figuras (o espaçamento da grelha é 10 unidades)

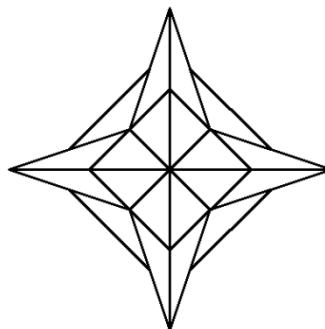
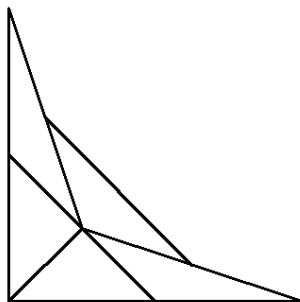
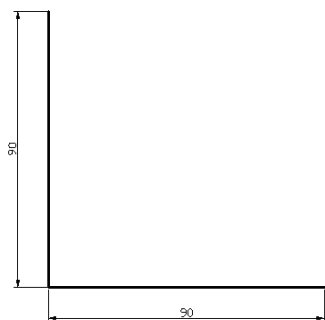
12.1.1



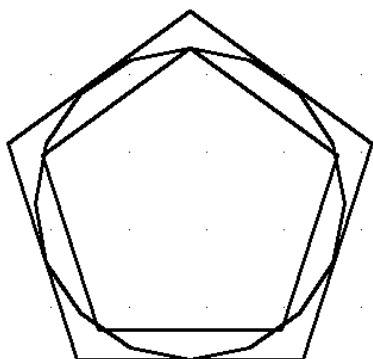
12.1.2



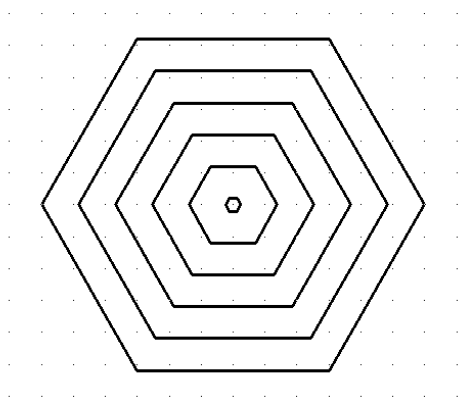
12.1.3 Transforme as duas linhas com 90 mm da figura da esquerda na figura do meio utilizando apenas OSNAP ao ponto do fim (ENDPOINT) e ao ponto do meio (MIDPOINT). Pode obter a estrela da direita utilizando o comando espelho (MIRROR).



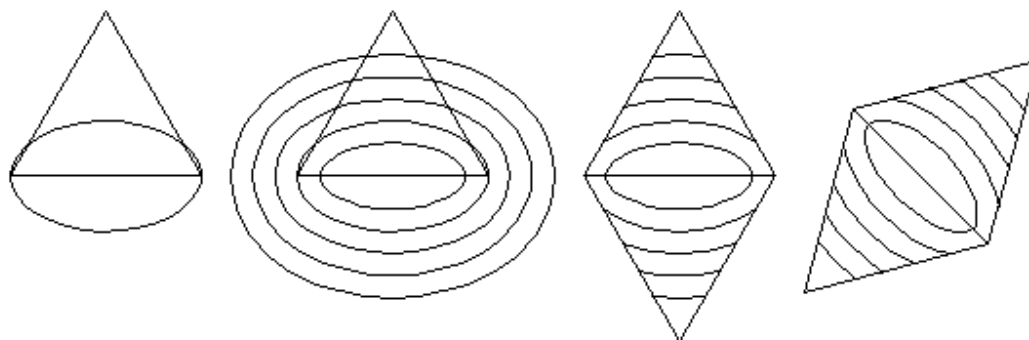
12.1.4 Desenhe um círculo com raio de 50 mm. Desenhe um polígono inscrito e outro que circunscreva o círculo (utilize SNAP ao centro para colocar os polígonos no centro do círculo).



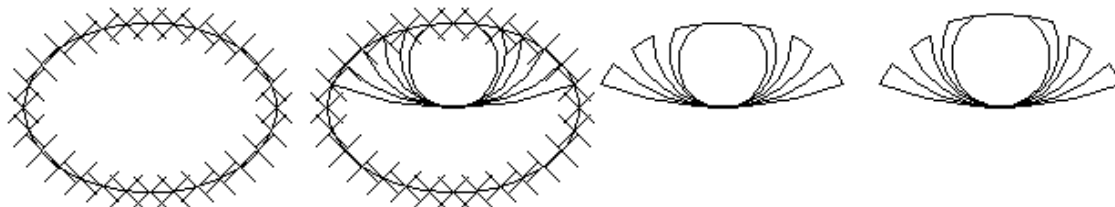
12.1.5 Desenhe um hexágono com raio de 60 mm. Desenhe 6 hexágonos no seu interior, utilizando um OFFSET de 10 mm.



12.1.6 Desenhe o triângulo com raio de 50 mm. Inscreve a elipse na base, utilizando SNAP (ao fim) (altura do elipse 25mm). Obtenha mais quatro elipses utilizando o OFFSET de 10 mm. Utilizando corte (TRIM) limpe as elipses fora do triângulo. Utilizando o espelho (MIRROR) obtenha a parte de baixo. Finalmente rode o objeto -45°.

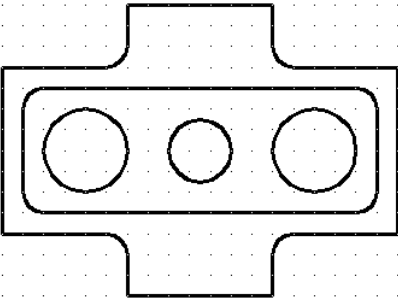
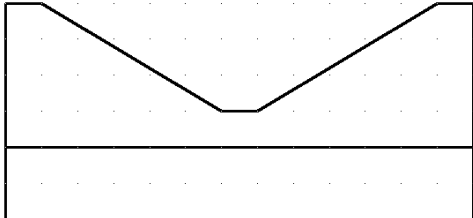
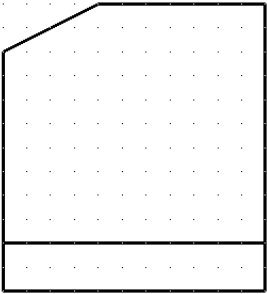
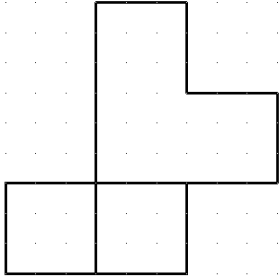


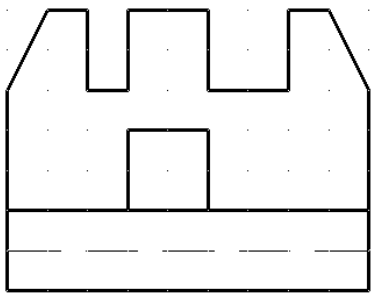
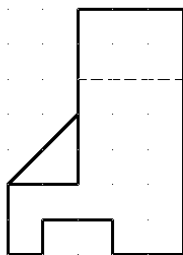
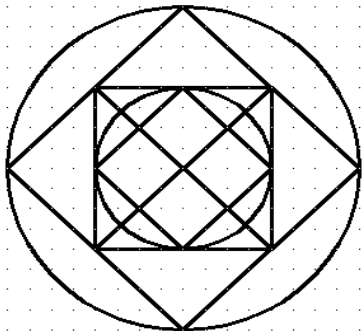
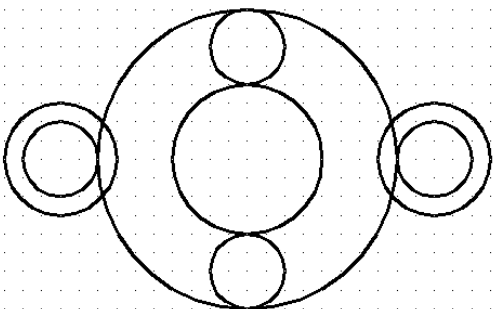
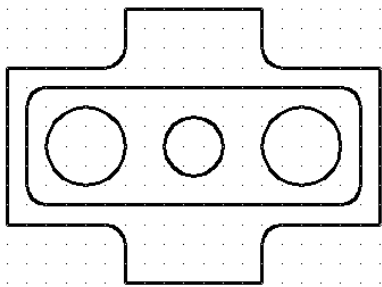
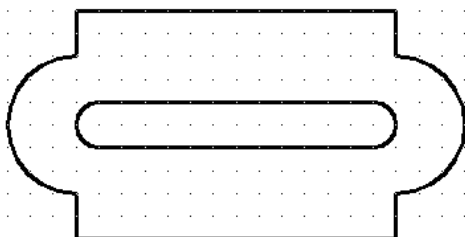
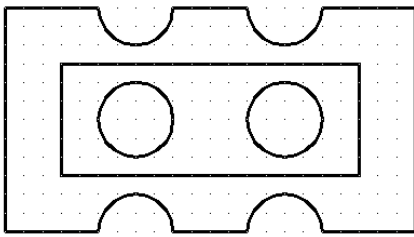
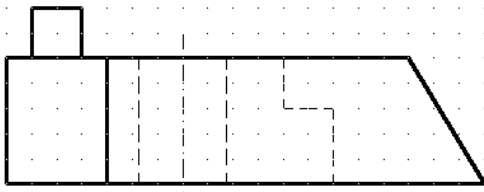
12.1.7 Desenhe uma elipse com 75 mm de comprimento e 25 mm de raio. Divida-o em 28 peças (POINT>DIVIDE). Aumente o tamanho dos pontos (POINT STYLE) para serem visíveis. Desenhe 6 arcos ligando pontos opostos da elipse, passando pelo seu centro (SNAP ao ponto e OSNAP ao centro da elipse). Limpe a figura. Finalmente amplie (SCALE) a parte do meio em 10%.

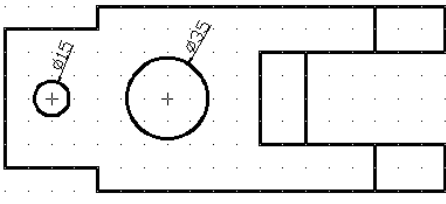
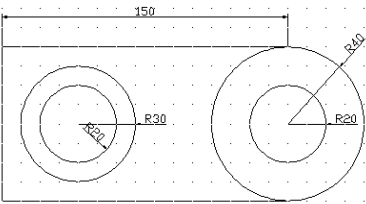
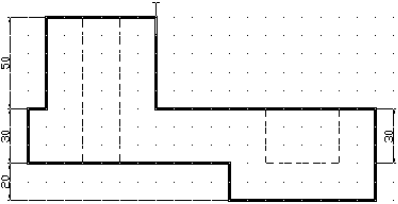
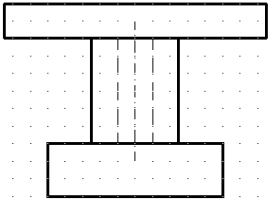
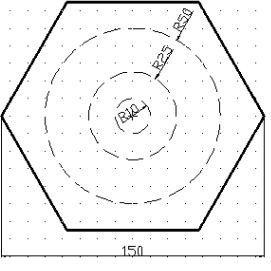
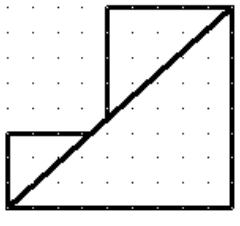
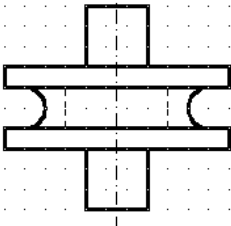
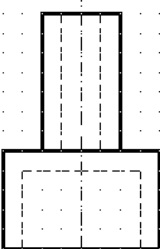
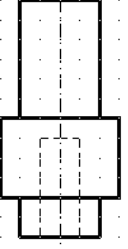
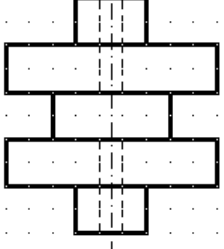


13. Trabalho não presencial

13.1 Desenhe as seguintes figuras (o espaçamento da grelha é 10 unidades).

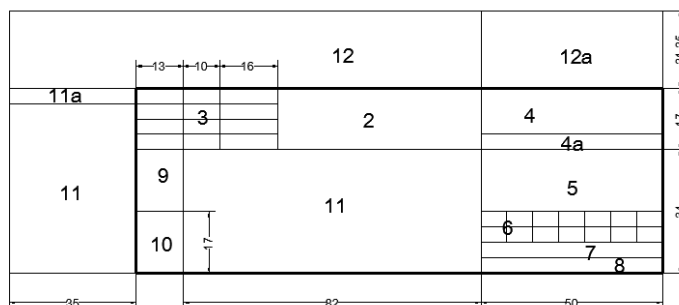
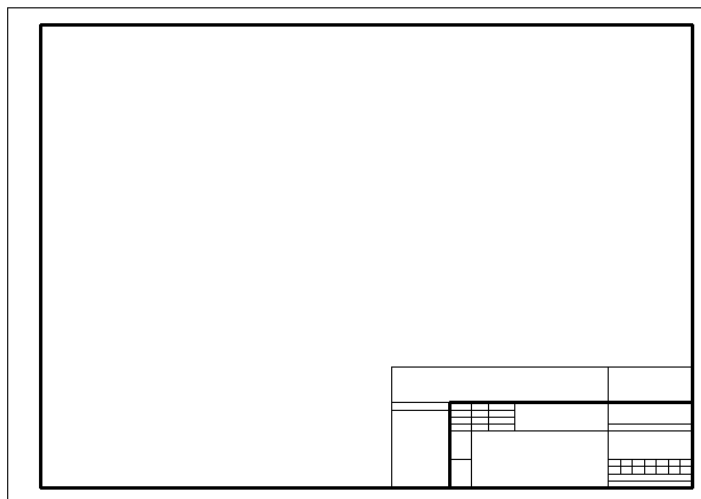
<p>13.1.1</p> 	<p>13.1.2</p> 
<p>13.1.3</p> 	<p>13.1.4</p> 

<p>13.1.5</p> 	<p>13.1.6</p> 
<p>13.1.7</p> 	<p>13.1.8</p> 
<p>13.1.9</p> 	<p>13.1.10</p> 
<p>13.1.11</p> 	<p>13.1.12</p> 

13.1.13 	13.1.14 
13.1.15 	13.1.16 
13.1.17 	13.1.18 
13.1.19 	13.1.20 
13.1.21 	13.1.22 

13.2

Normalização: Desenhe a esquadria e a legenda numa folha A3 de acordo com norma NP-204 (ligue o comando ORTHO). Guarde esta folha para utilizar sempre que precisar.



II – Projeções e cotação







Capacidades a adquirir nesta aula:

- Utilizar a cotação para indicar a forma e a localização dos elementos de uma peça;
- Selecionar criteriosamente as cotas, as vistas onde devem ser inscritas e a sua orientação;
- Aplicar as técnicas de cotação de modo a garantir a legibilidade, simplicidade e clareza do desenho em AutoCAD;
- Apresentar os desenhos com as cotas numa camada diferente;
- Solicitar ao computador propriedades dos objetos desenhados.

1. Definição e formatação da cotação

1.1 Toolbar Dimension

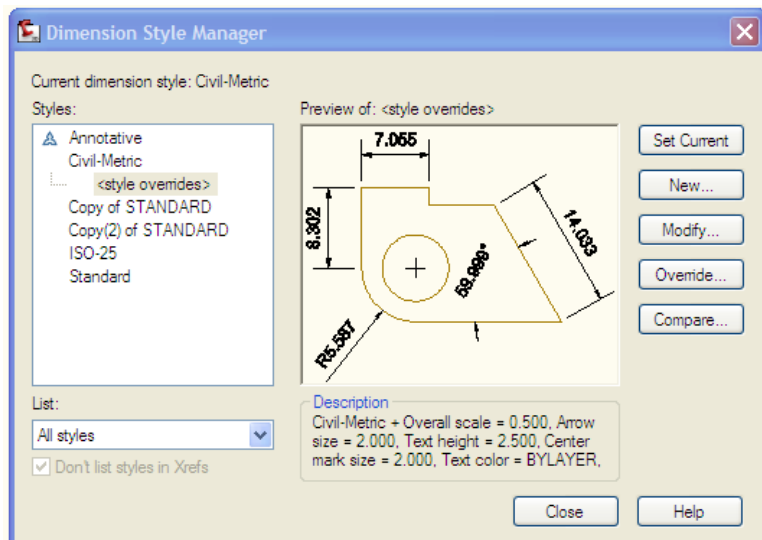


	Dimensão linear
	Dimensão alinhada
	Dimensão radial
	Dimensão diametral
	Dimensão angular
	Dimensão paralela
	Dimensão contínua



Permite formatar a legenda

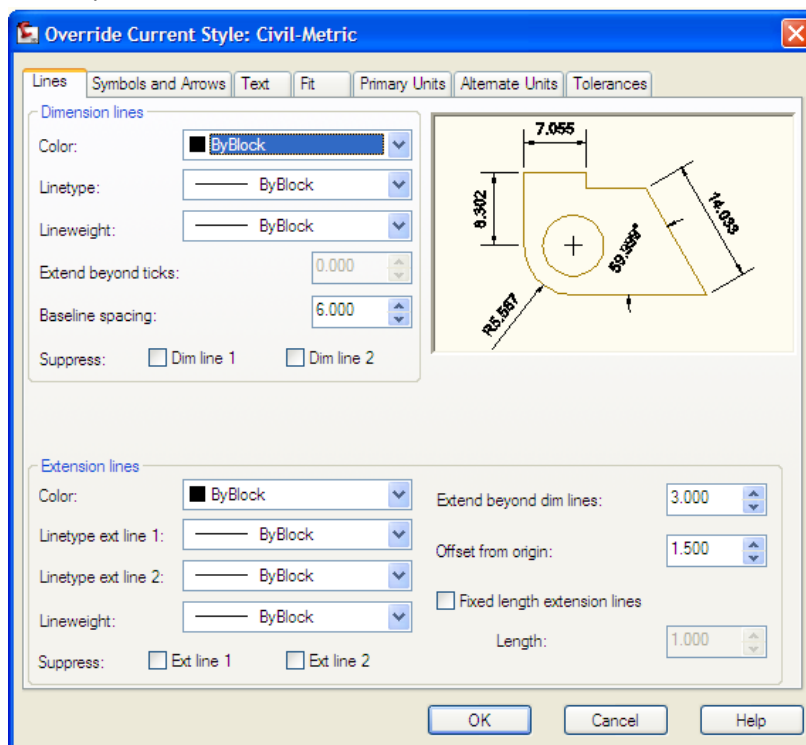
1.2 FORMAT / Dimension styles - Permite definir as características dos elementos de cotação.



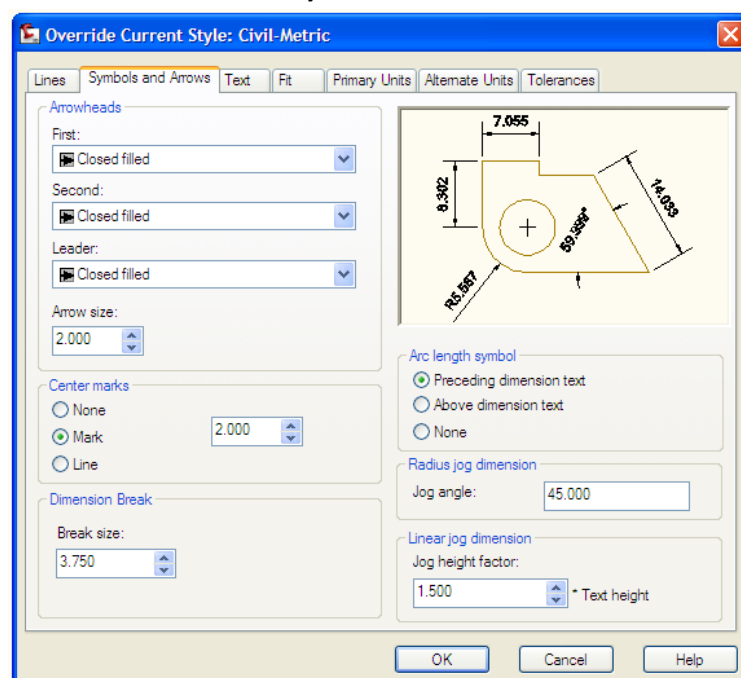
Para alterar a formatação dos elementos de cotação deve clicar em “Modify”.

Surge uma nova janela com os menus: “Lines”, “Symbols and Arrows”, “Text” e “Primary units”, permitindo adequar a formatação dos elementos de cotação à especificidade de cada desenho ou projeto.

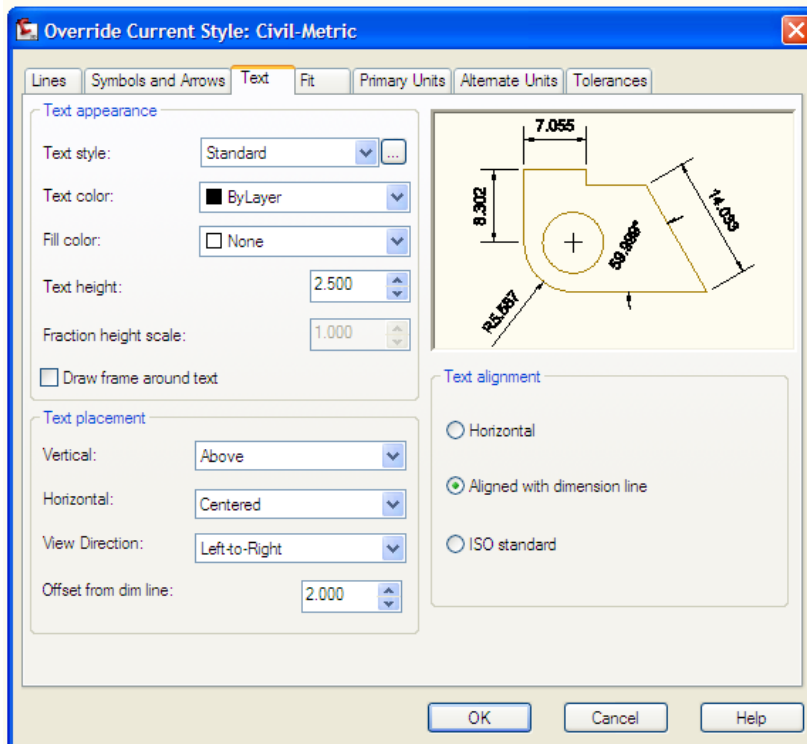
1.2.1 Tipo de linha utilizada - Line



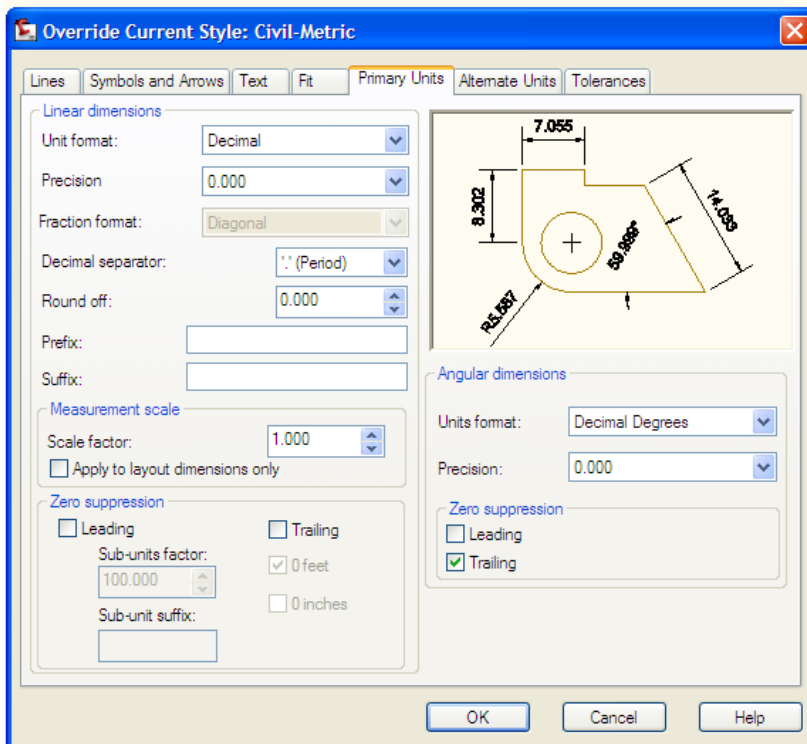
1.2.2 Símbolos e setas - Symbols and Arrows



1.2.3 Texto - Text



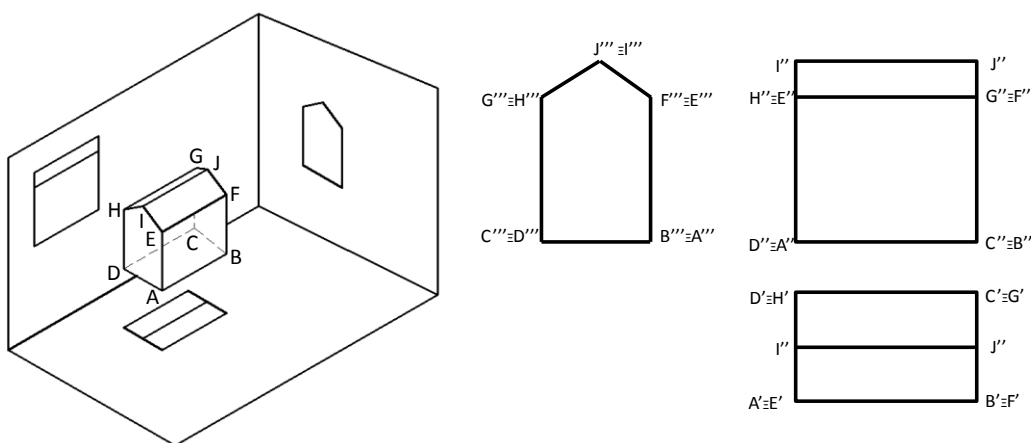
1.2.4 Unidades - Primary units



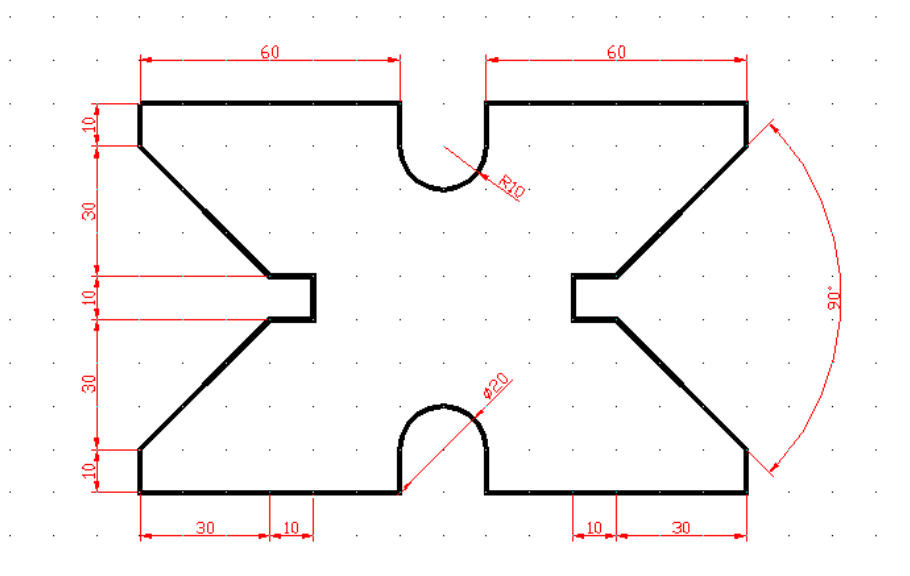
2. Ensino presencial

2.1 A partir da figura da esquerda desenhe a sua projeção de acordo com o método Europeu, de acordo com as indicações:

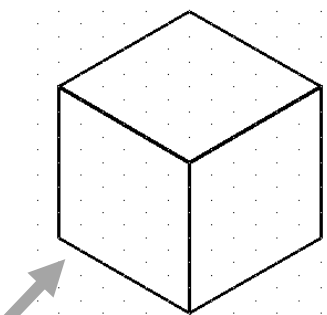
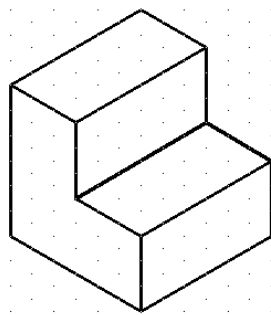
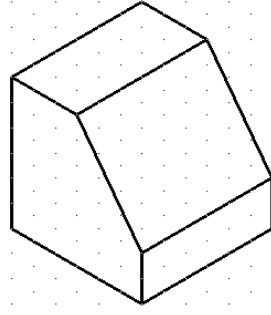
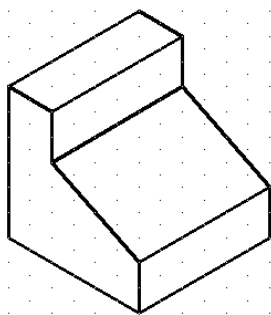
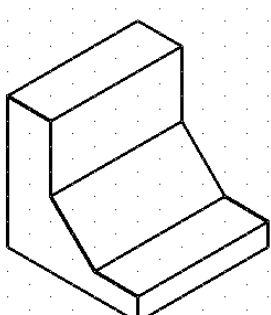
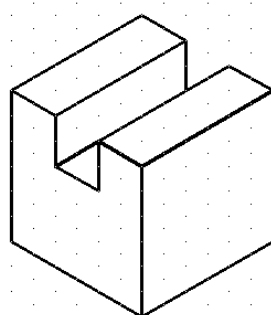
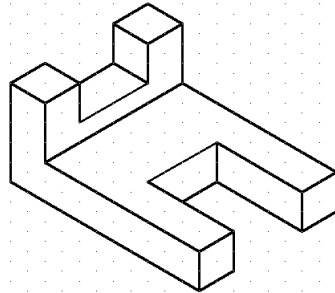
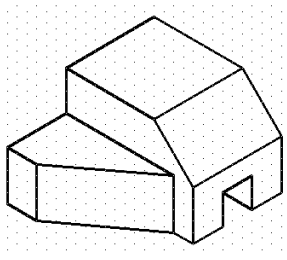
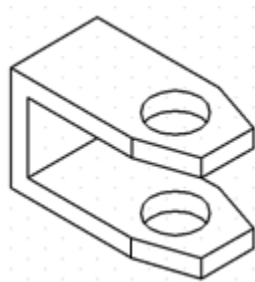
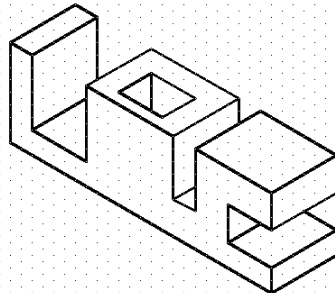
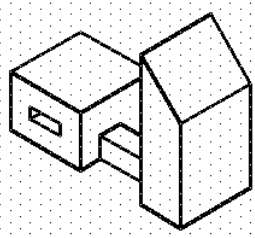
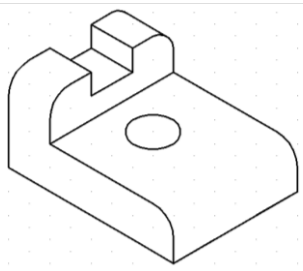
- identificação de todos os vértices (de A a J);
- projeção dos vértices em três planos perpendiculares, por exemplo no plano vertical, no plano horizontal e plano lateral;
- colocar as vistas de acordo com o método Europeu.



2.2 Desenhe o seguinte objeto. Para definir espessuras de linha, escolha a opção Width (**W**).

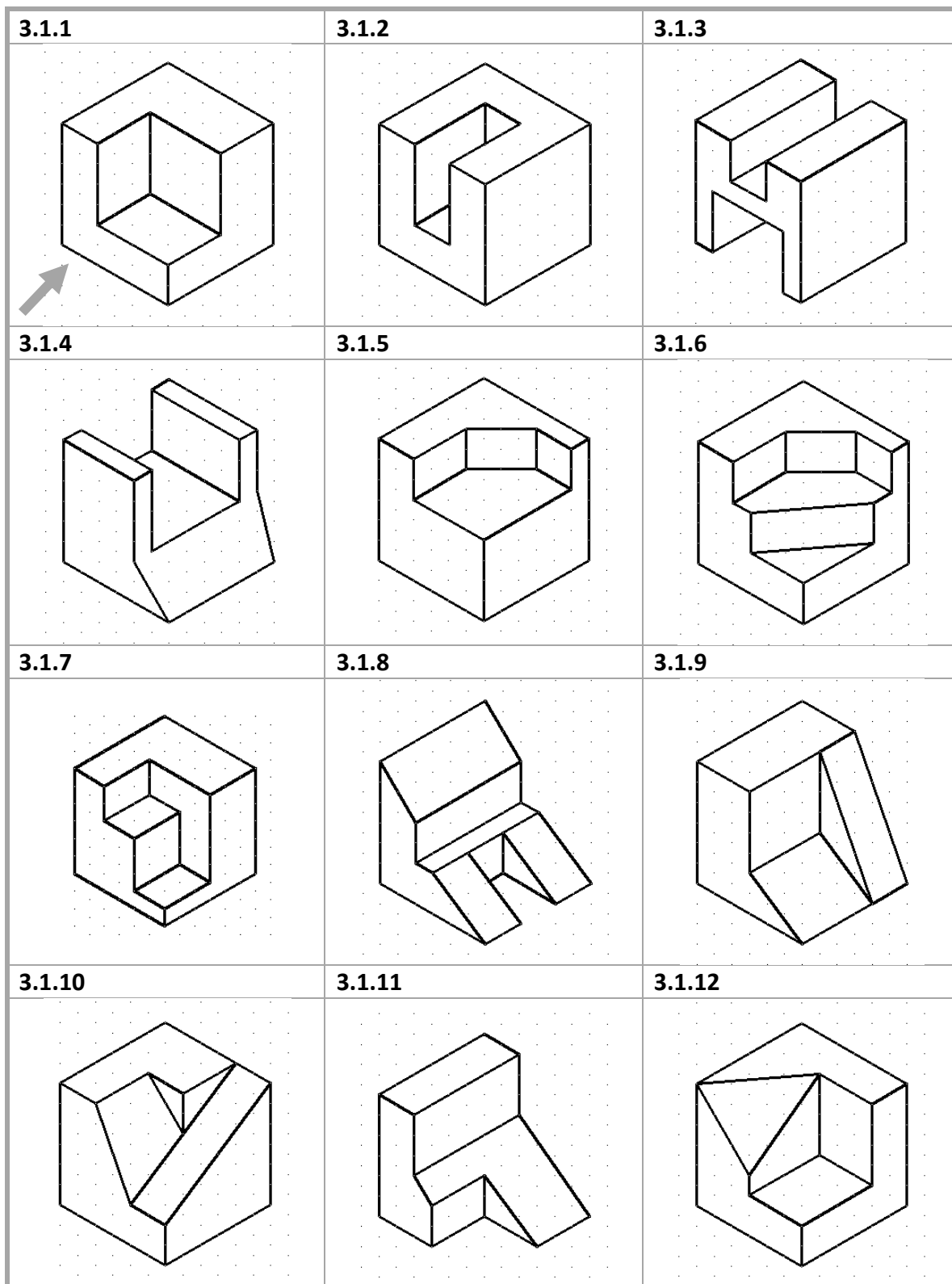


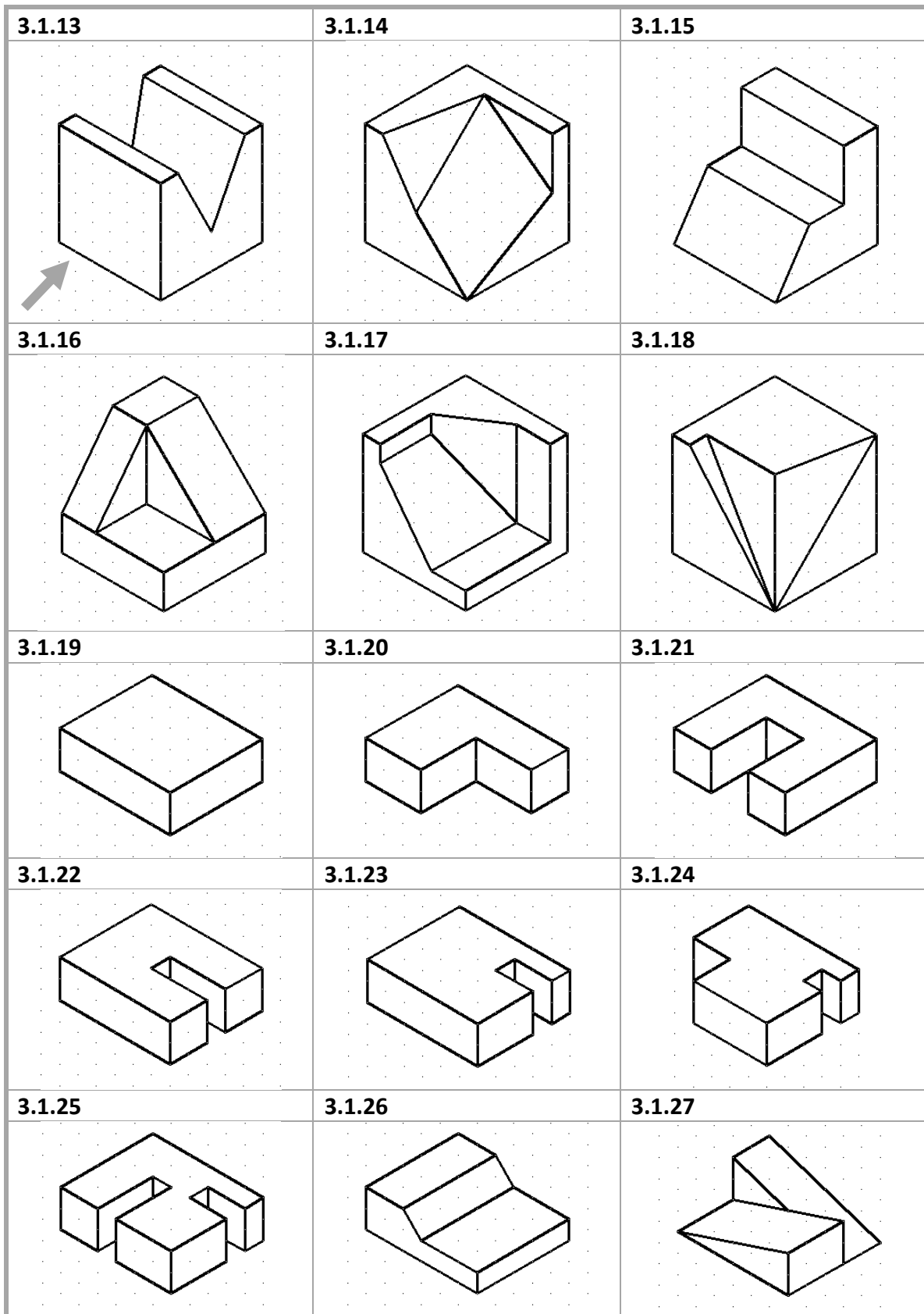
2.3. Projeções ortogonais. Desenhe, segundo o método Europeu, as projeções ortogonais necessárias para definir os objetos a seguir indicados (o espaçamento da grelha é 10 unidades e a seta a cinzento indica o alçado principal). Proceda à sua cotagem num nível (layer) diferente daquele onde fez as projecções ortogonais, utilizando, por exemplo, a cor amarela.

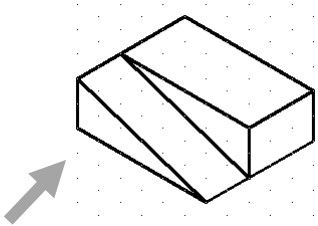
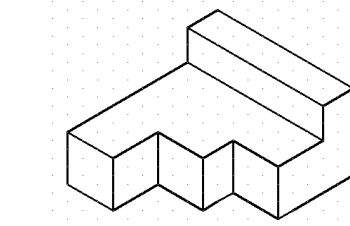
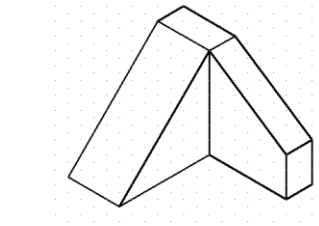
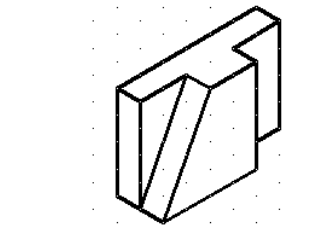
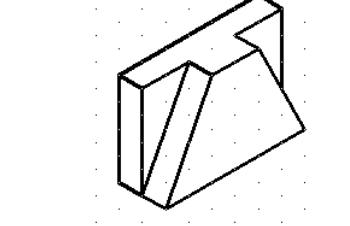
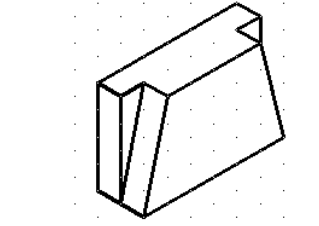
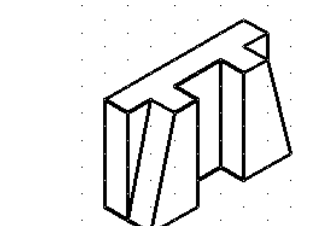
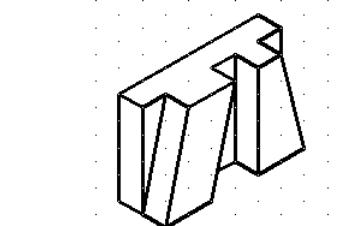
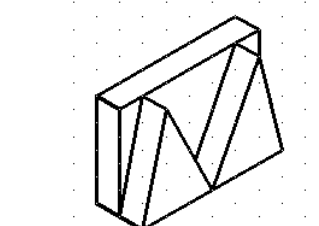
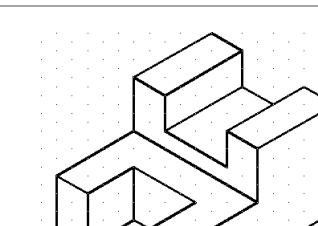
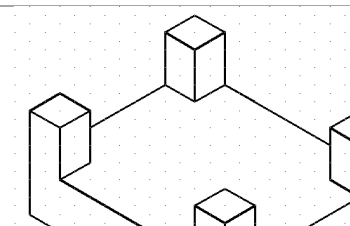
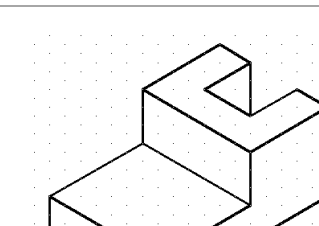
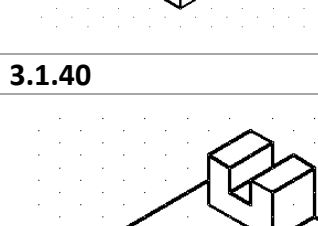
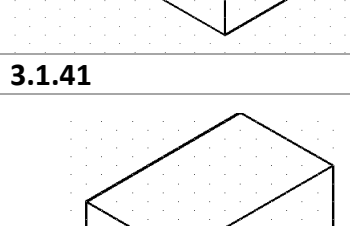
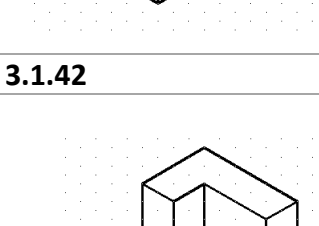
2.3.1	2.3.2	2.3.3
		
2.3.4	2.3.5	2.3.6
		
2.3.7	2.3.8	2.3.9
		
2.3.10	2.3.11	2.3.12
		

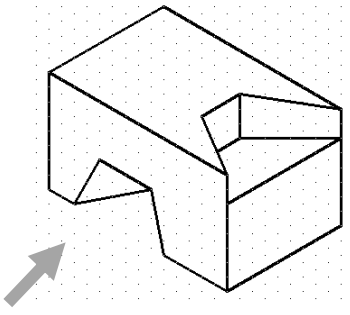
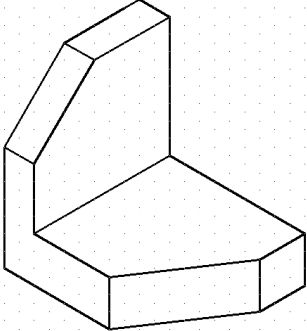
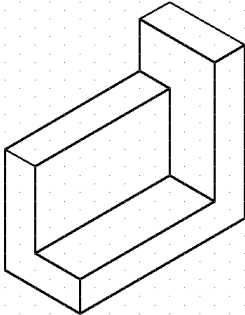
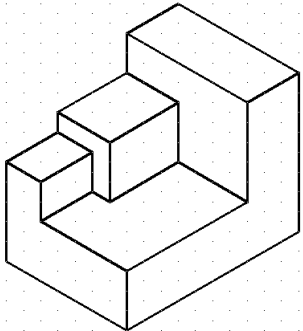
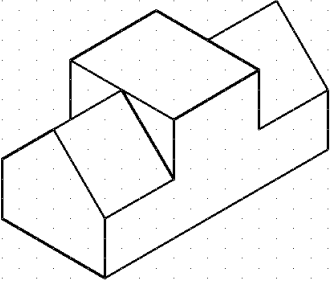
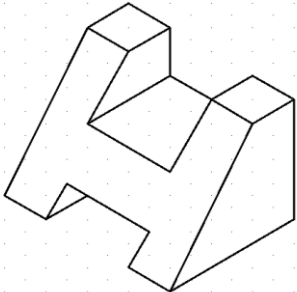
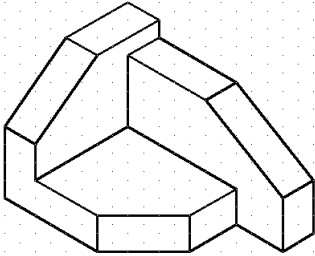
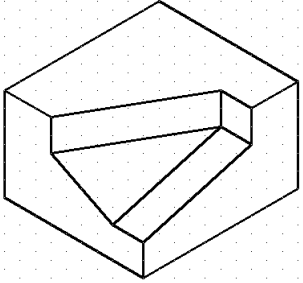
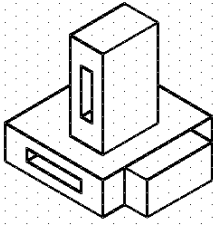
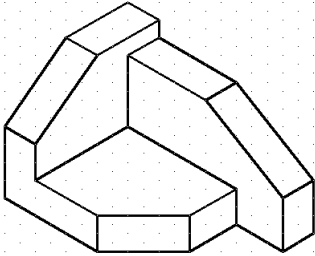
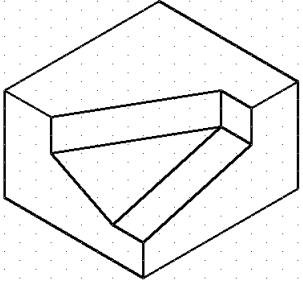
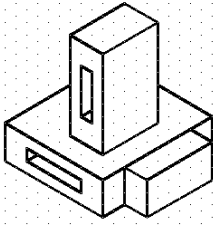
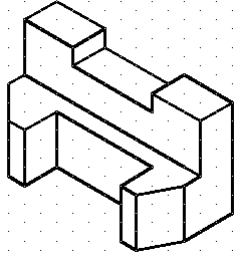
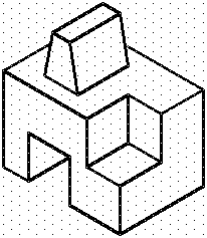
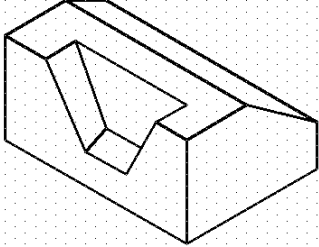
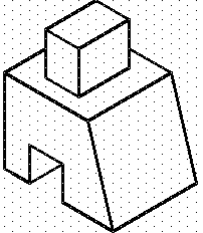
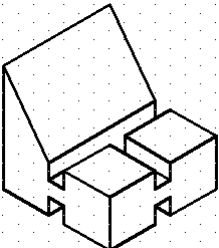
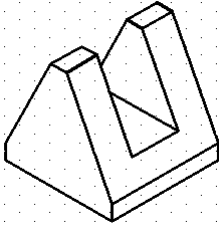
3. Trabalho não presencial

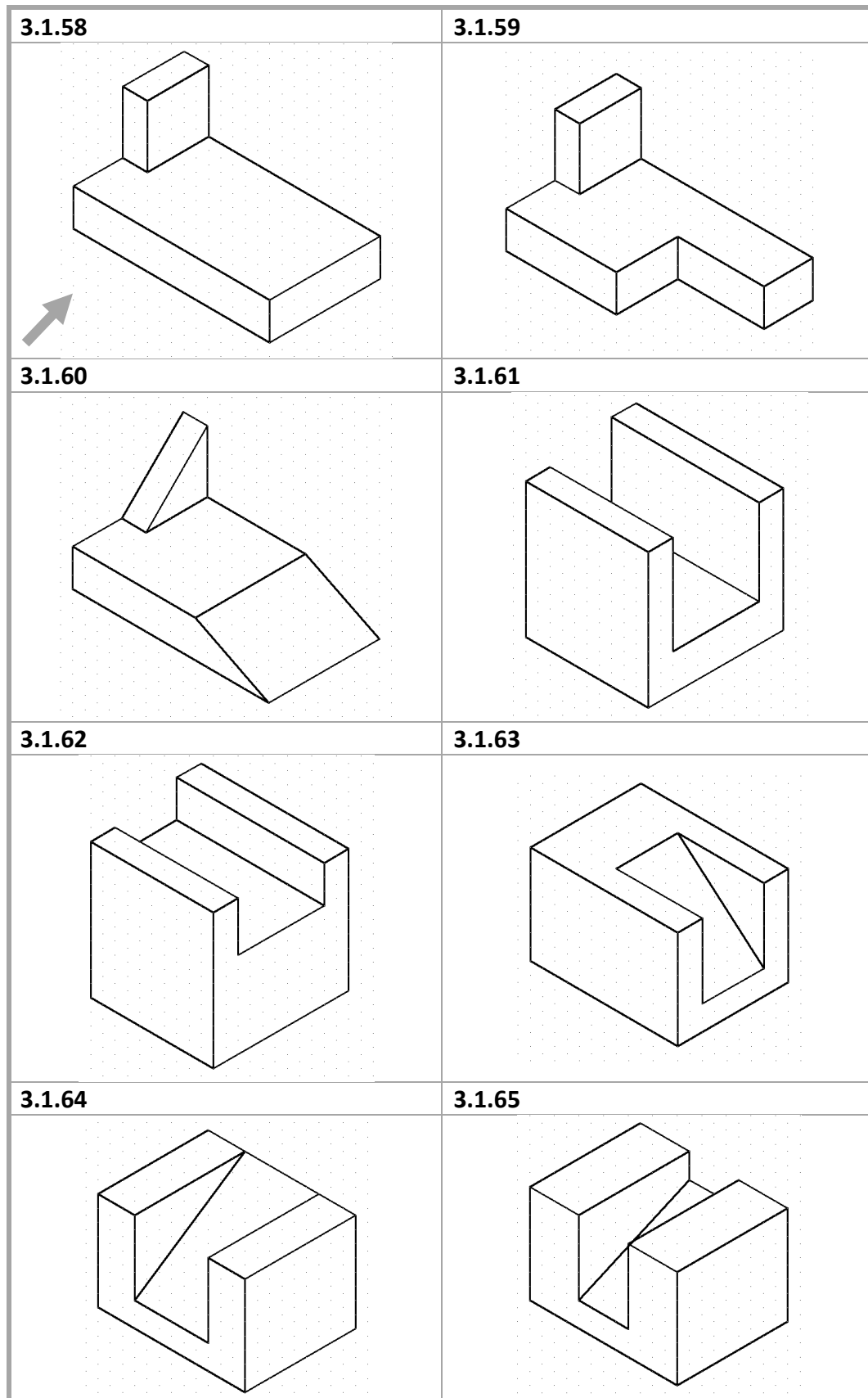
3.1 Desenhe, segundo o método Europeu, as projeções ortogonais necessárias para definir os seguintes objetos (o espaçamento da grelha é 10 unidades e a seta a cinzento indica o alçado principal). Proceda à sua cotação num nível (layer) diferente daquele onde fez as projecções ortogonais, utilizando, por exemplo, a cor amarela.

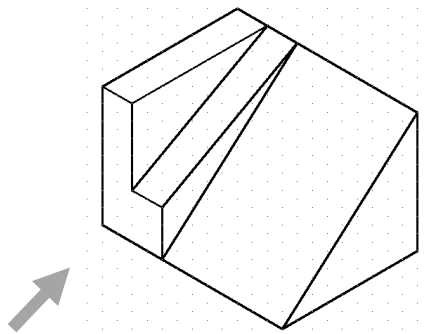
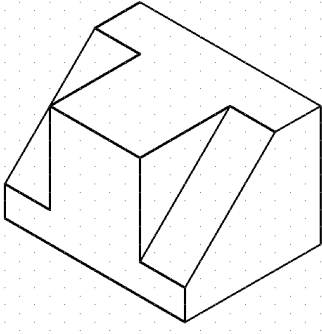
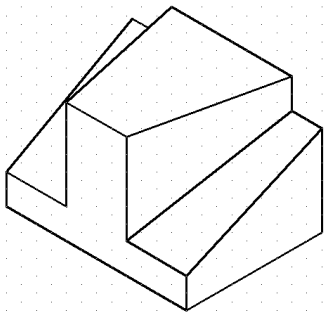
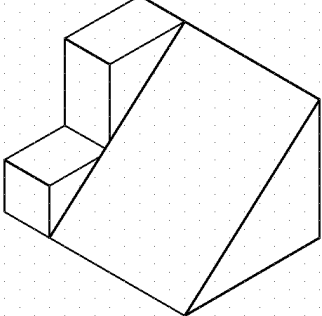
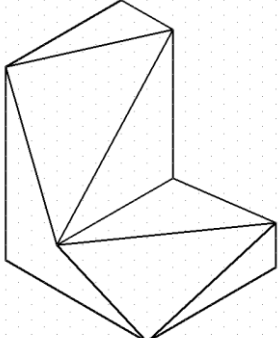
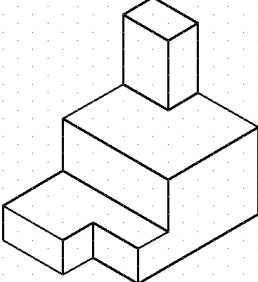
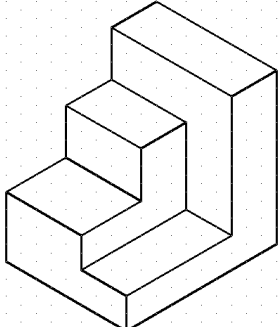
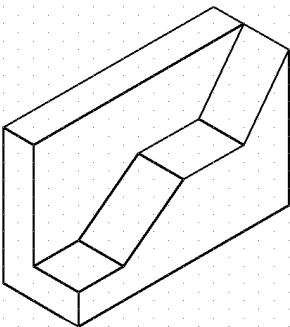


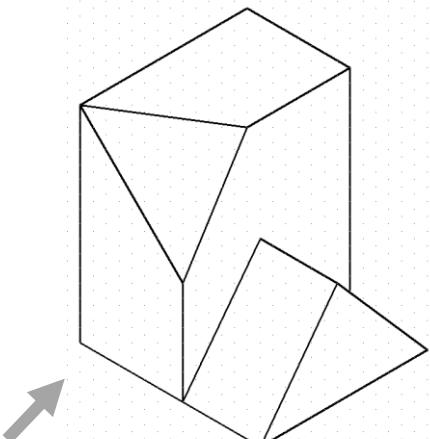
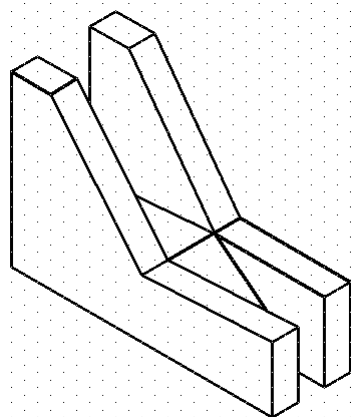
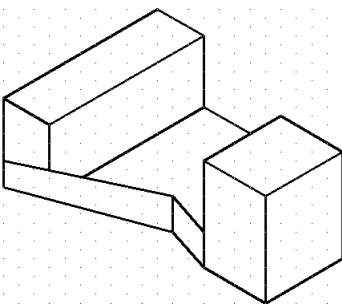
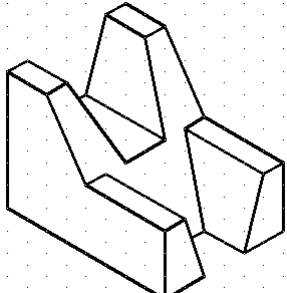
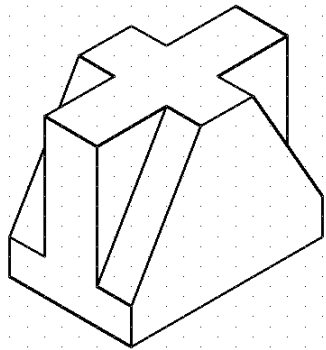
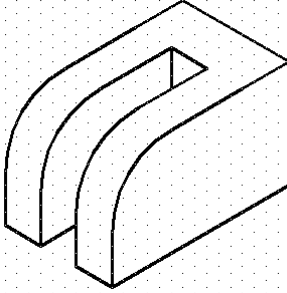
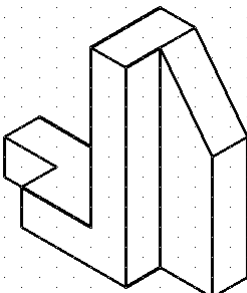
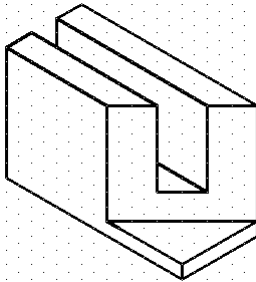


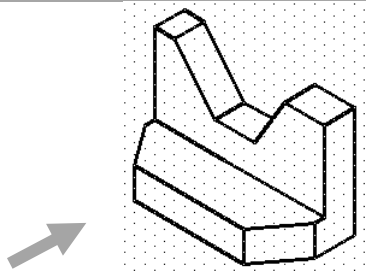
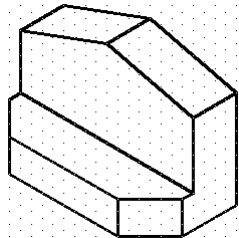
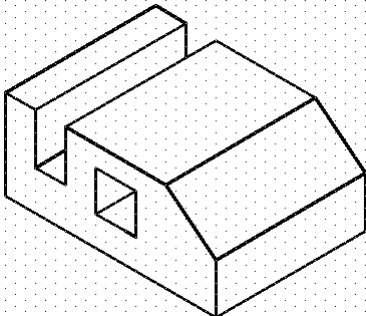
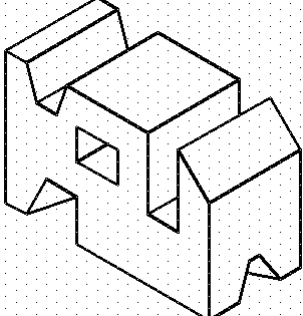
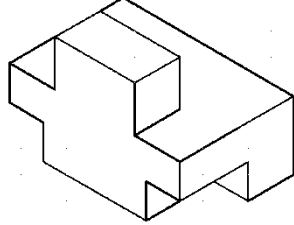
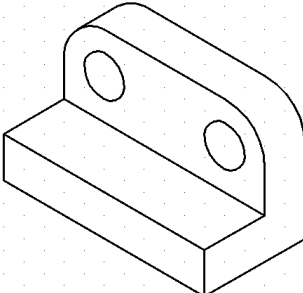
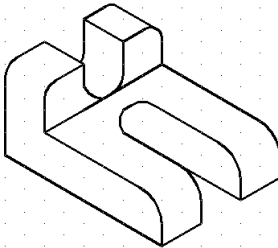
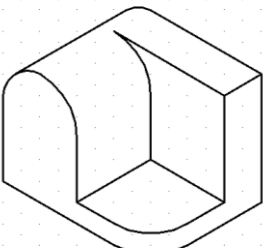
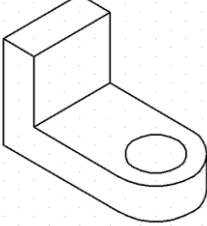
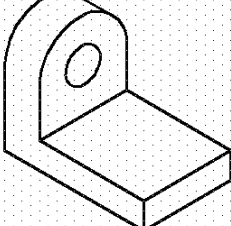
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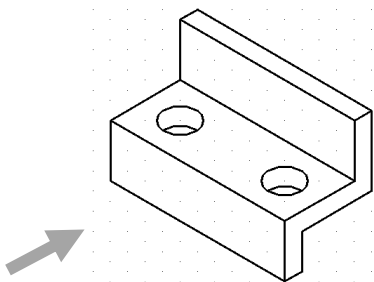
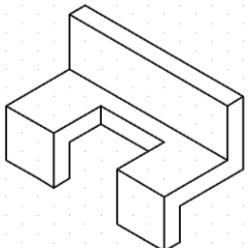
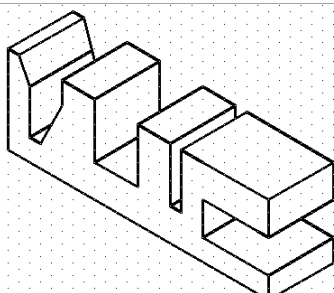
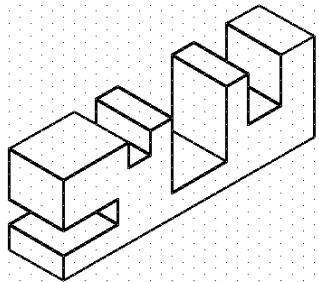
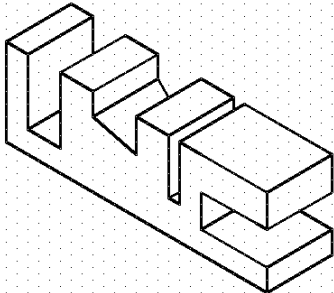
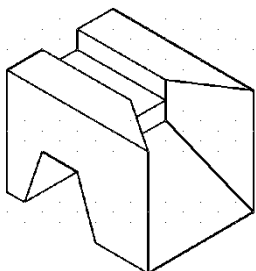
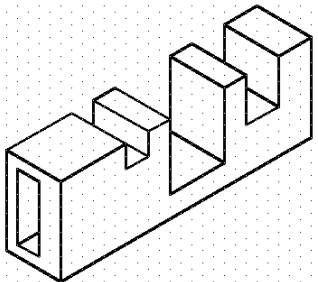
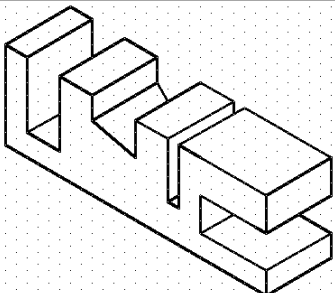
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3.1.55 	3.1.56 	3.1.57 
		



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3.1.76 	3.1.77 
3.1.78 	3.1.79 
3.1.80 	3.1.81 

3.1.82 	3.1.83 
3.1.84 	3.1.85 
3.1.86 	3.1.87 
3.1.88 	3.1.90 
3.1.100 	3.1.101 

3.1.102 	3.1.103 
3.1.104 	3.1.105 
3.1.106 	3.1.107 
3.1.108 	3.1.109 

III– Perspetivas

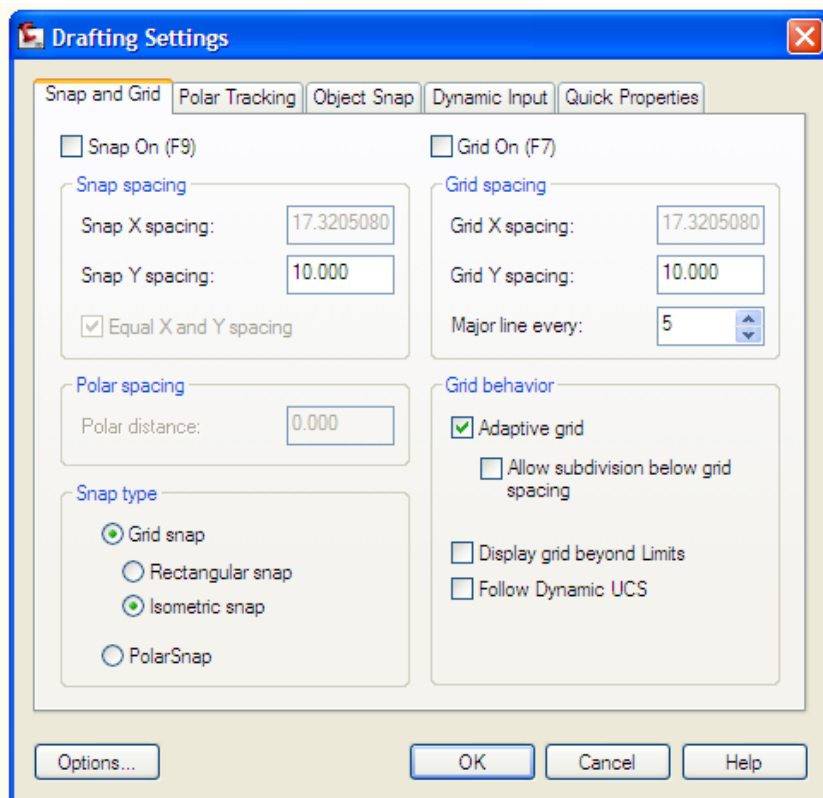
Capacidades a adquirir nesta aula:

- a) Desenhar rigorosamente a perspetiva de qualquer objeto;
- b) Desenhar a perspetiva de um objeto a partir da sua representação em vistas múltiplas

1. Seleção de grelha isométrica

Na elaboração de uma perspetiva deve usar-se a grelha isométrica.

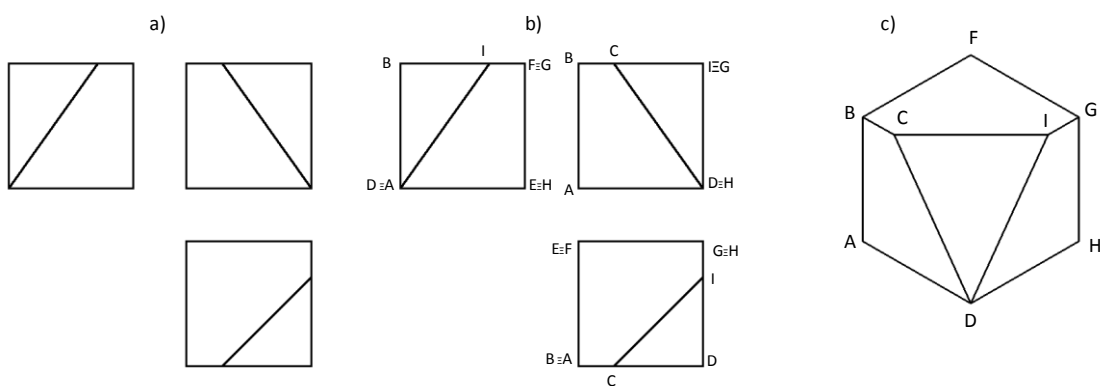
Ao colocar o cursor na barra de ferramentas inferior, clique no botão do lado direito do rato. Na janela que surge, clique em “Settings” e na janela “Drafting Settings” selecione a instrução “Isometric snap” em “Snap type”.



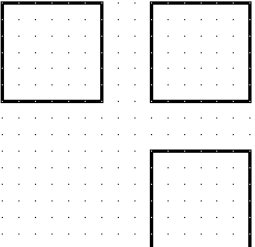
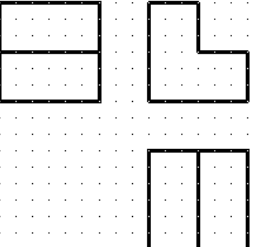
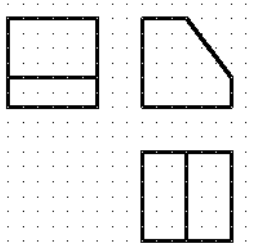
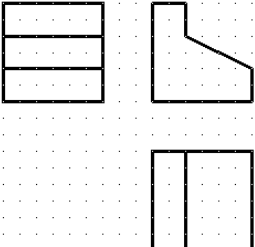
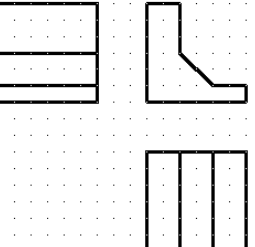
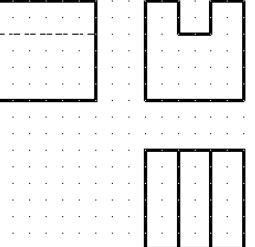
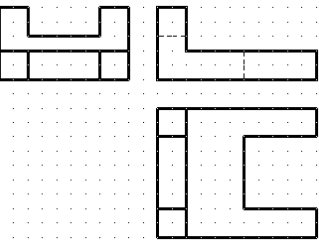
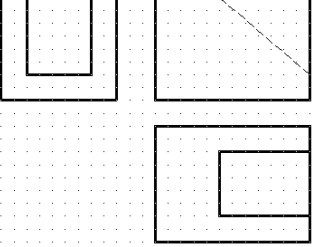
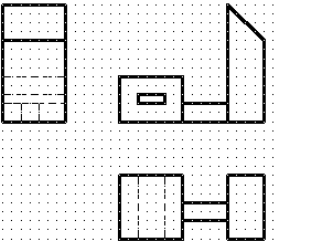
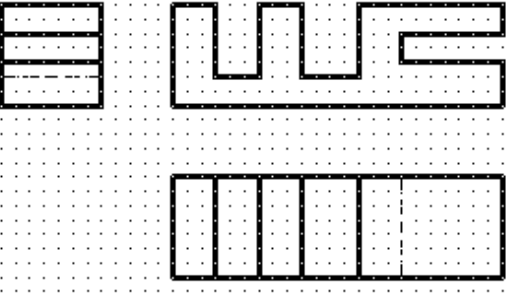
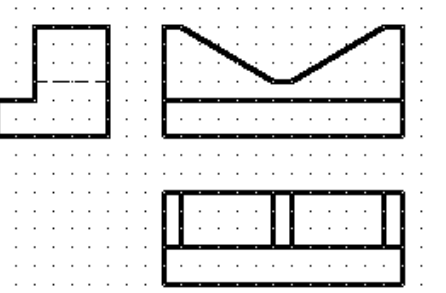
2. Ensino presencial

2.1 Na visualização das vistas em volume haverá que ter em atenção a relação observador-objeto-plano de projeção. Assim, quando se analisa a planta deve ter-se a noção que se está a ver o objeto de cima, se for o alçado principal será de frente e se for o alçado lateral de lado. A partir da figura a) desenhe a sua perspetiva, de acordo com as indicações:

- identificar as vistas, na figura a);
- fazer a análise conjunta de duas vistas identificando as arestas comuns às duas e analisar todas as vistas em conjunto, para identificar todos os vértices e arestas;
- identificar de todos os vértices (de A a I) e arestas (figura b);
- desenhar os vértices e arestas ao longo dos eixos isométricos, obtendo-se assim a perspetiva (figura c)

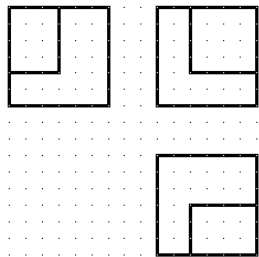
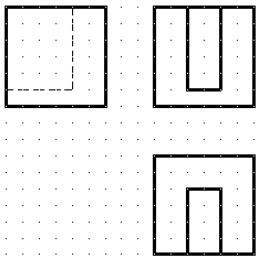
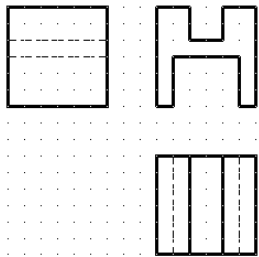
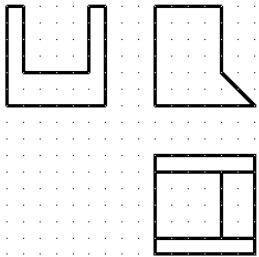
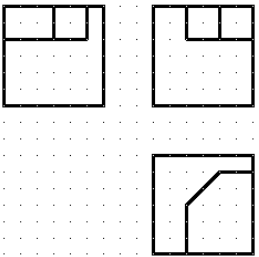
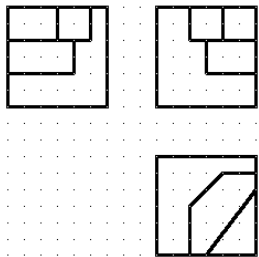
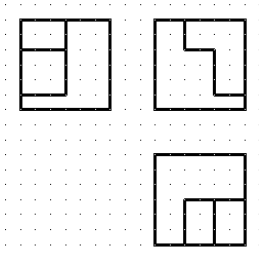
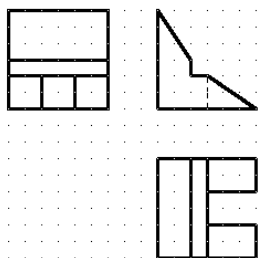
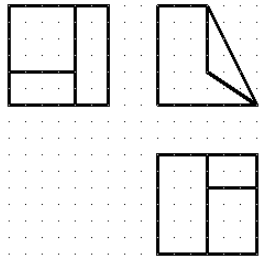
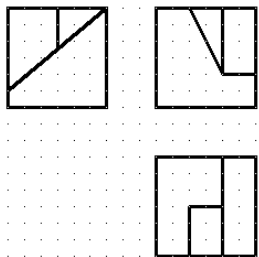
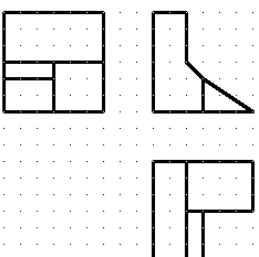
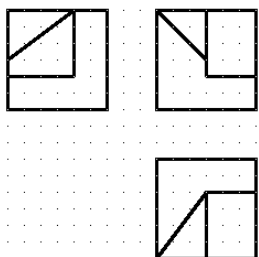
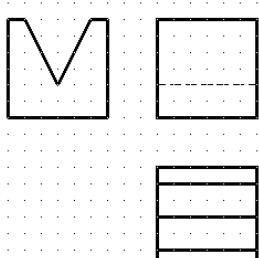
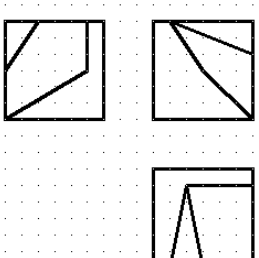
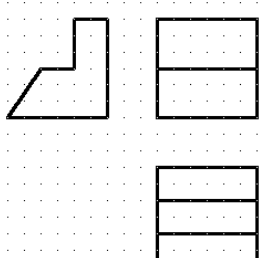


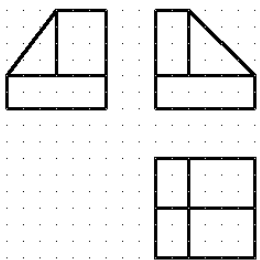
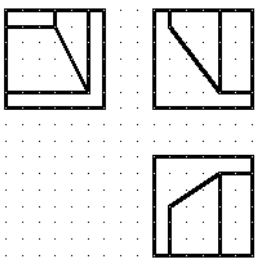
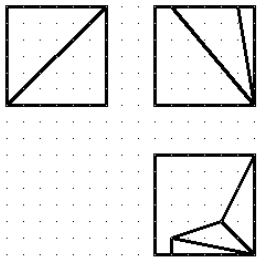
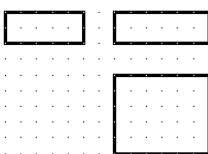
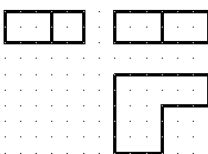
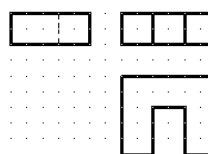
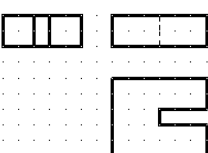
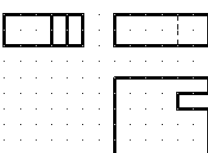
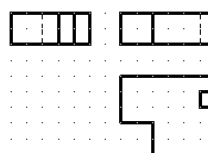
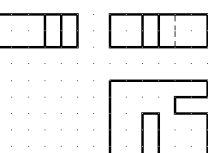
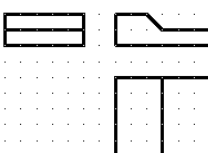
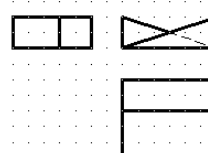

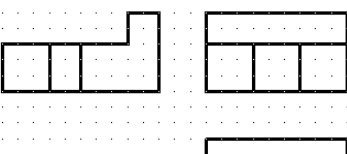
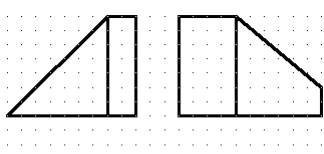
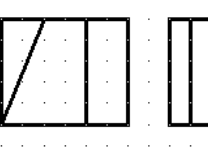
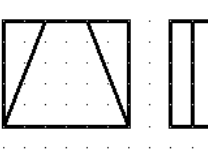
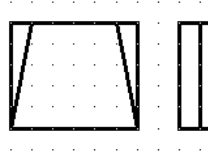
2.2 As figuras seguintes representam as projeções ortogonais de objetos. Desenhe cada um desses objetos em perspetiva axonométrica isométrica (o espaçamento da grelha é 10 unidades).

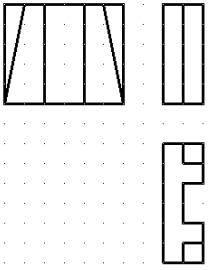
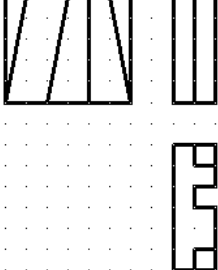
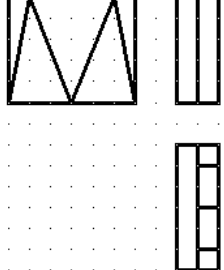
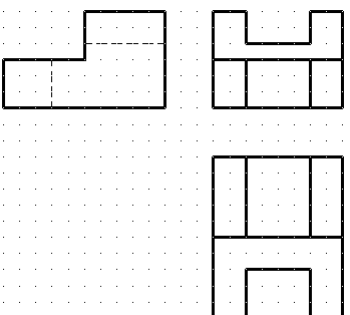
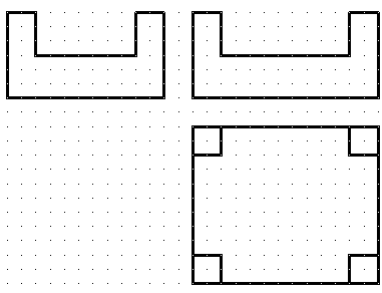
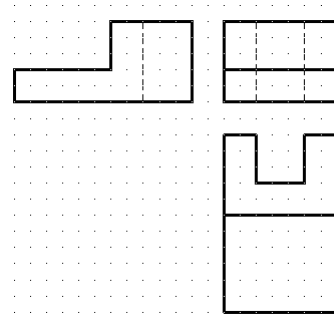
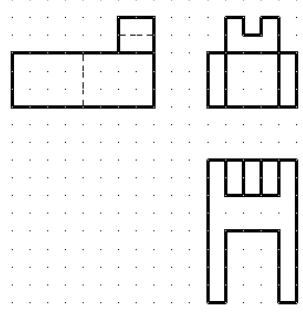
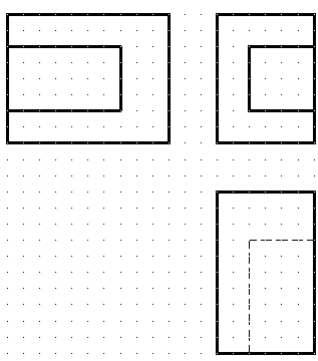
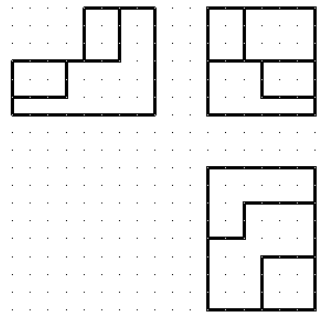
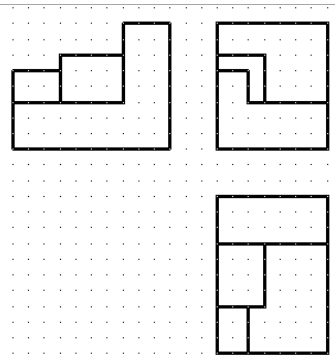
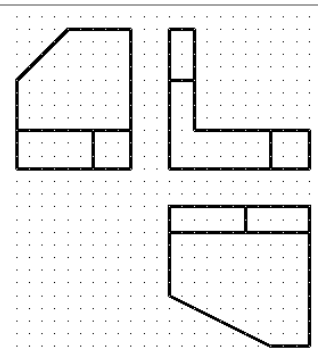
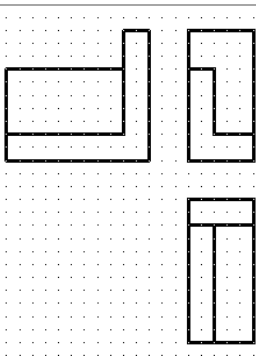
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2.2.10 		2.2.11 

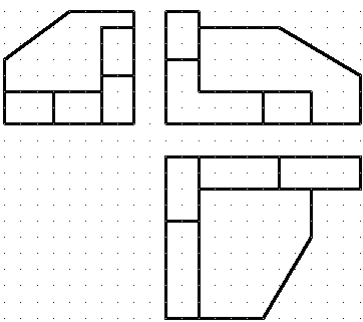
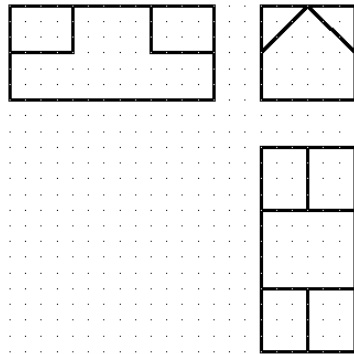
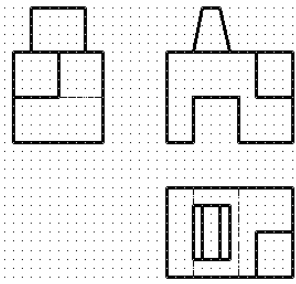
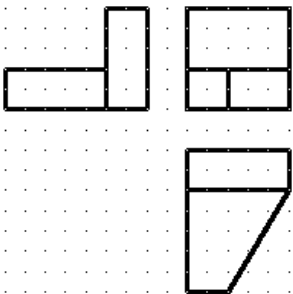
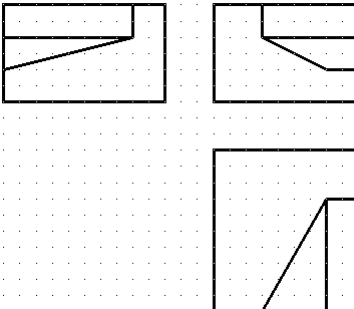
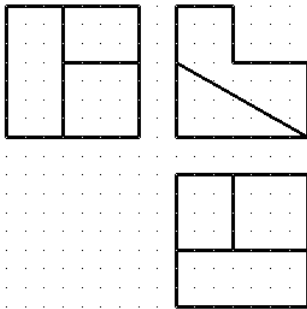
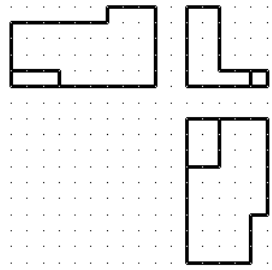
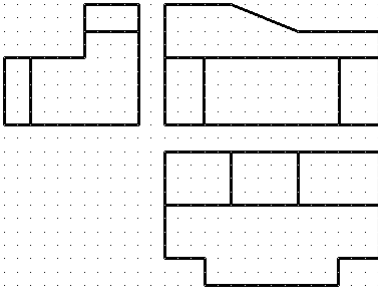
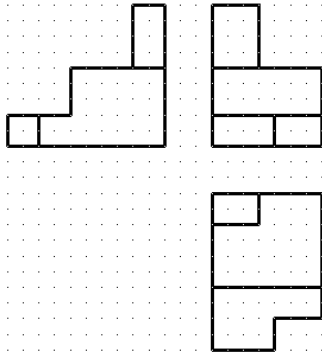
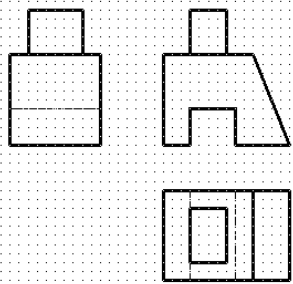
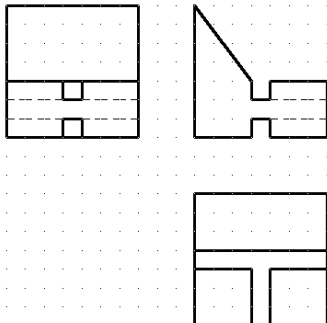
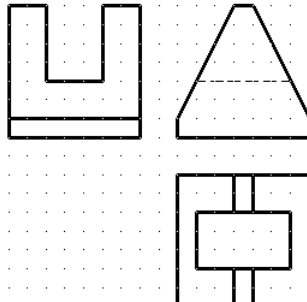
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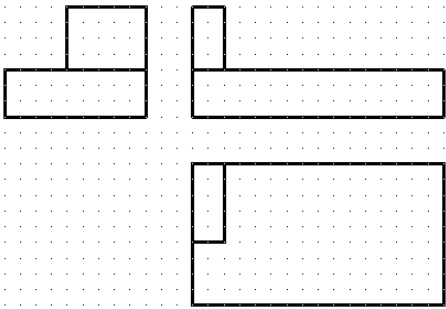
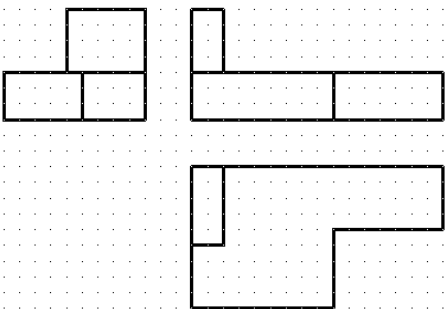
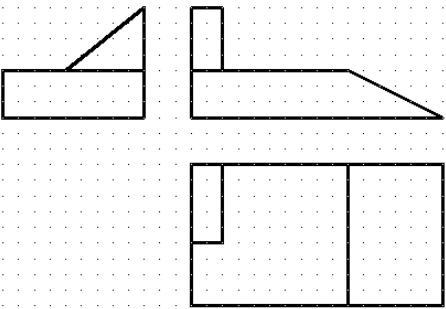
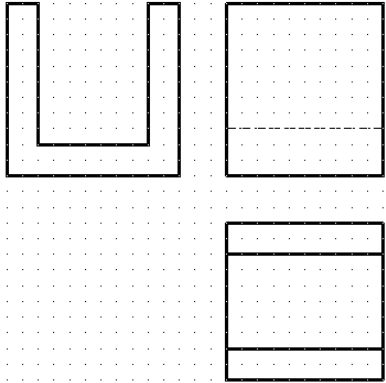
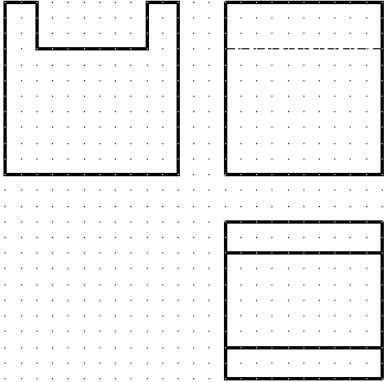
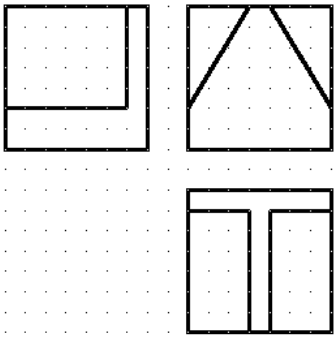
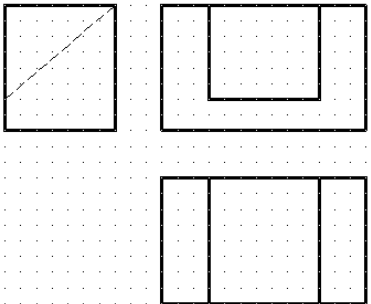
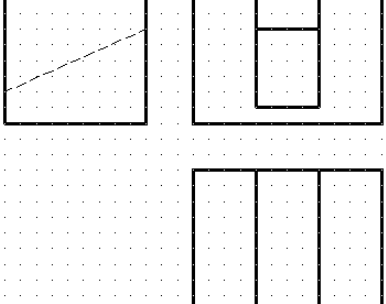
As figuras representam as projeções ortogonais de um objeto pelo método Europeu. Desenhe os objetos em perspectiva axonométrica isométrica (o espaçamento da grelha é 10 unidades).

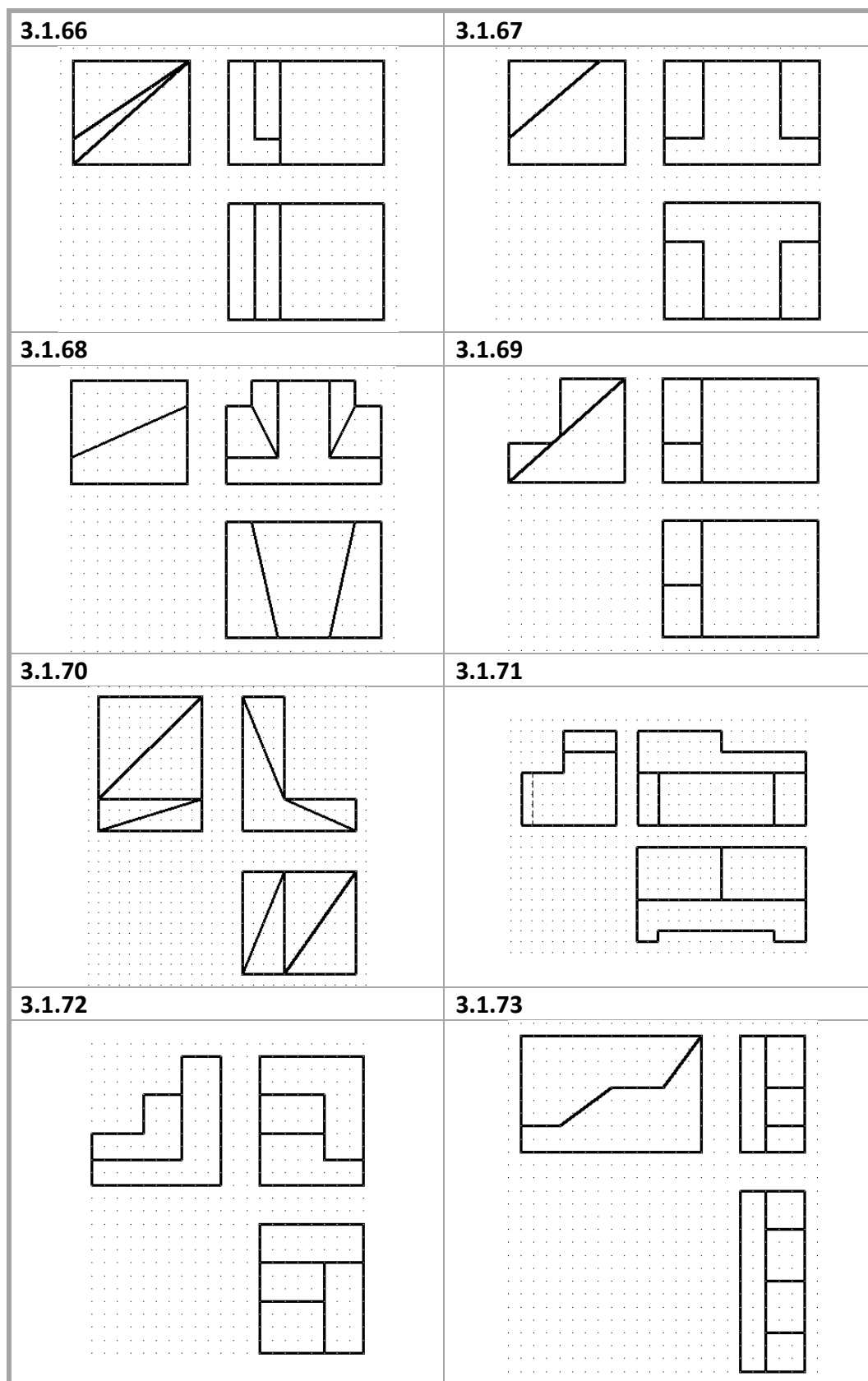
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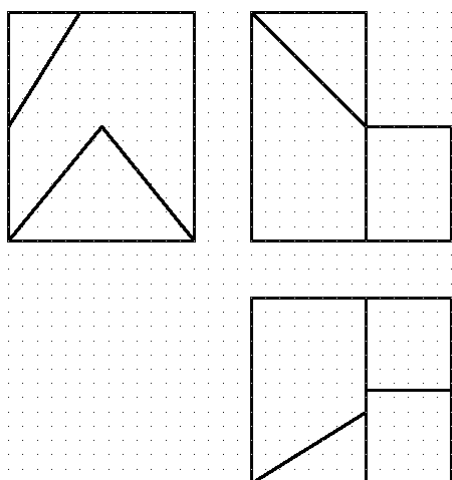
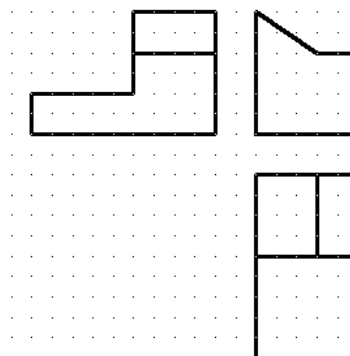
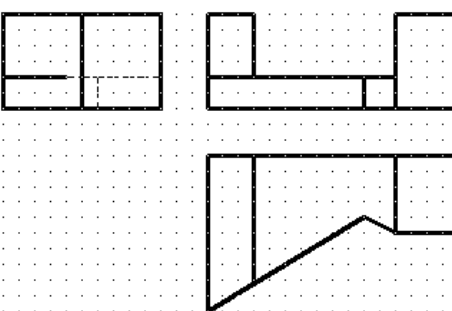
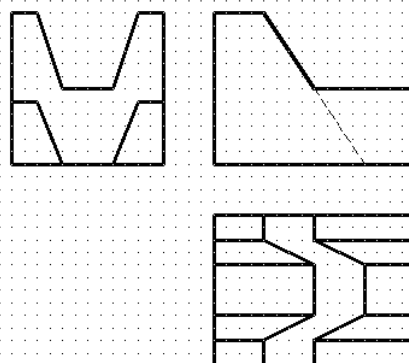
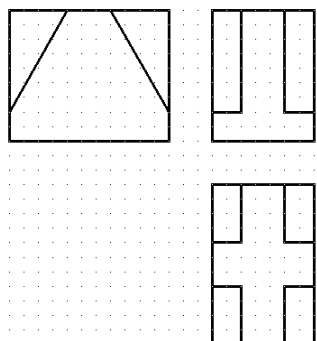
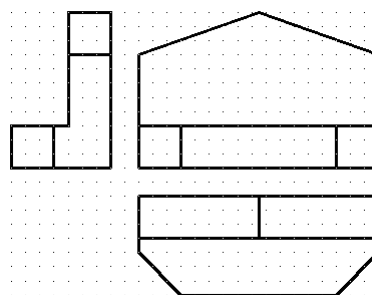
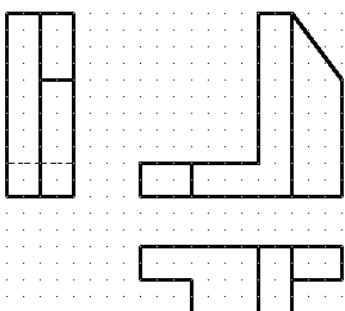
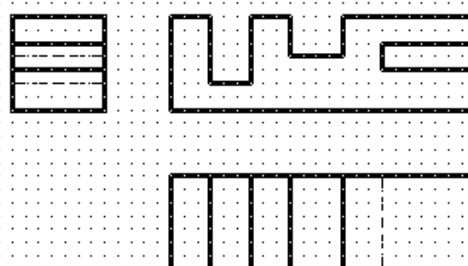
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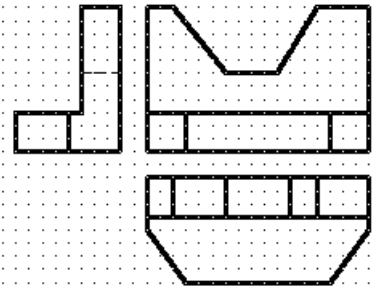
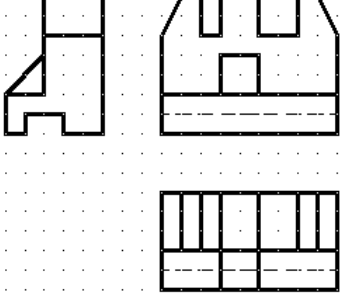
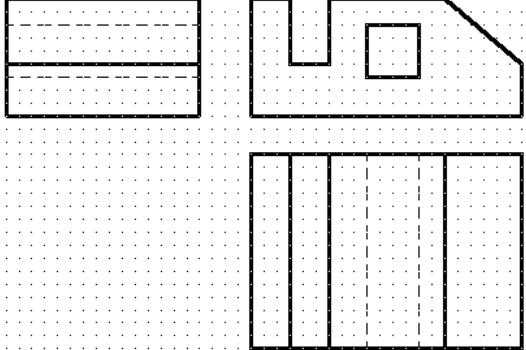
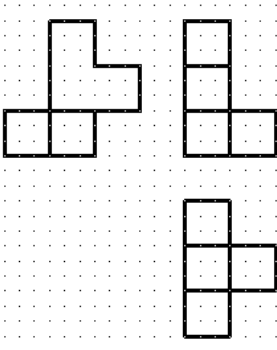
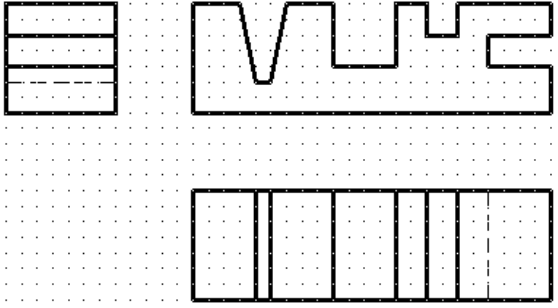
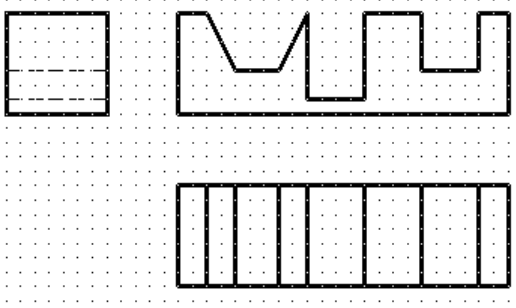
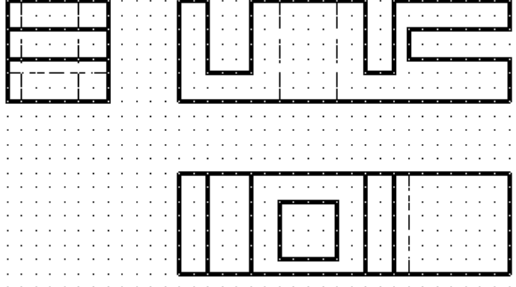
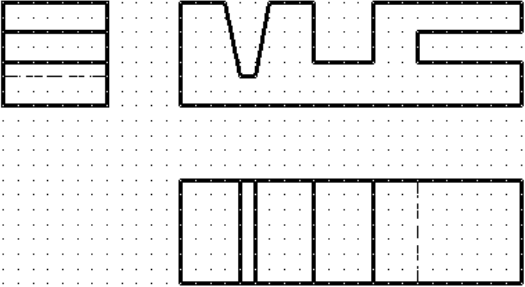
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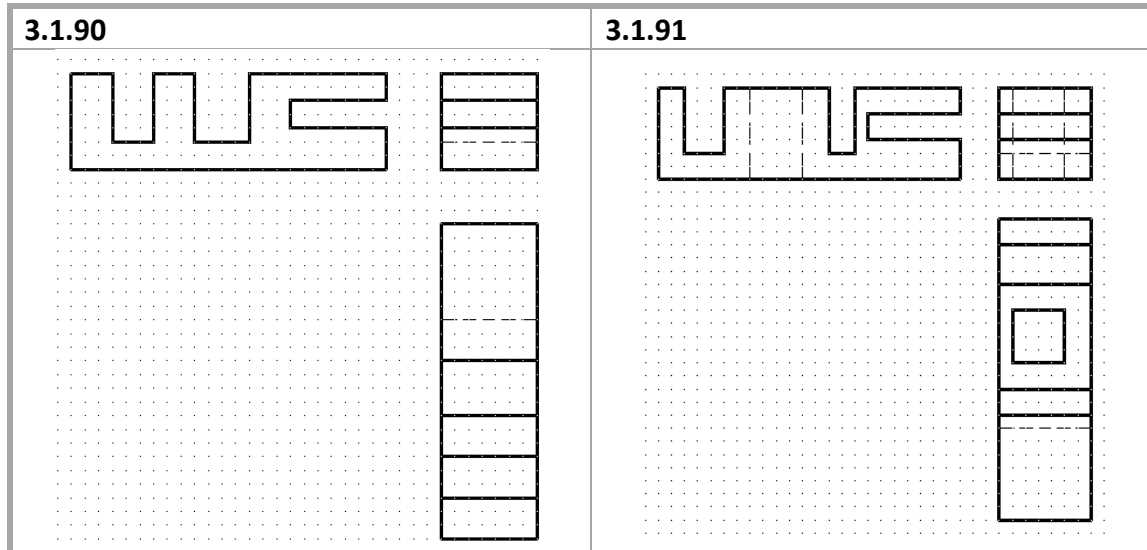
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3.1.58 	3.1.59 
3.1.60 	3.1.61 
3.1.62 	3.1.63 
3.1.64 	3.1.65 



3.1.74

3.1.75

3.1.76

3.1.77

3.1.78

3.1.79

3.1.80

3.1.81


3.1.82 	3.1.83 
3.1.84 	3.1.85 
3.1.86 	3.1.87 
3.1.88 	3.1.89 



IV – Desenho a três dimensões, cortes e secções

Capacidades a adquirir nesta aula:

Aspetos complementares de desenho a 2D

- a) Saber abrir e ocultar os vários TOOLBARS.
- b) Utilizar MULTILINE e trabalhar com blocos;
- c) Modificar objetos desenhados utilizando EXPLODE, BREAK e STRETCH;
- d) Editar Poli-linhas.


Construção de peças a 3D

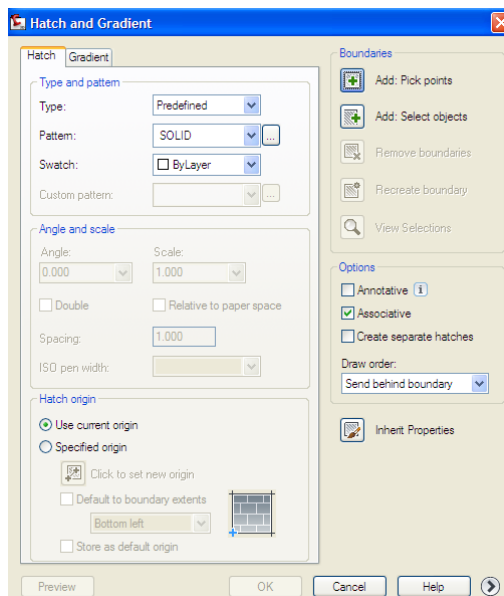
- a) Transformar linhas e arcos em poli-linhas;
- b) Utilizar os comandos REVOLVE e EXTRUDE para obter objetos 3D simples;
- c) Utilizar várias janelas e pontos de vista (VIEWPOINT).

Cortes e secções

- a) Saber as normas de desenho de cortes e secções;
- b) Decidir sobre a necessidade de recorrer a cortes ou secções para representar completamente uma peça em projeções ortogonais;
- c) Saber optar entre um corte ou uma secção;
- d) Optando por um corte, selecionar o mais adequado;
- e) Compreender e saber trabalhar com o sistema de coordenadas UCS.

1. Aspetos complementares do desenho a 2D


Na barra de ferramentas “Draw” o ícone “Hatch”,  permite preencher uma área com um determinado padrão. Após a seleção do ícone “Hatch” surge a janela abaixo indicada. Selecione o padrão pretendido em “Pattern”. Com exceção do padrão “Solid”, deve também selecionar o ângulo (“Angle”) e a escala (“Scale”) pretendida, tendo o cuidado na sua adequação à dimensão do desenho. Para preenchimento da área deve selecionar “Add: Pick points” ou “Add: Select objects” em “Boundaries”. Clique na zona pretendida e faça “OK”.



2. Transformação de linhas e arcos em poli-linhas

Toolbar **Modify II**



Para transformar linhas e arcos em poli-linhas selecione “Edit polyline”, , na barra de ferramentas “Modify II”. Esta tarefa executa-se seguindo as instruções da linha de comando, podendo ser efetuada de duas formas (Opções A e B). Para cada opção indica-se com letra normal as instruções da linha de comando e indica-se com letra a negrito as respostas a colocar na referida linha de comando. As linhas e os arcos devem intersestar-se e não deve haver linhas sobrepostas para se fechar a poli-linha.

2.1. Opção A

Select polyline or [Multiple]:

Clicar em cima de uma linha ou arco do objeto

Object selected is not a polyline

Do you want to turn it into one? <Y> **y**

Enter an option [Close/Join/Width/Edit vertex/Fit/Spline/Decurve/Ltype gen/Reverse/Undo]: **j**

Select objects:

Selecione as linhas e arcos

enter

2.2 Opção B

Select polyline or [Multiple]:**m**

enter

Select objects:

Selecione as linhas e arcos

enter

Convert Lines, Arcs and Splines to polylines [Yes/No]? **Y**

enter

Enter an option [Close/Open/Join/Width/Fit/Spline/Decurve/Ltype gen/Reverse/Undo]: **J**

enter

Enter fuzz distance or [Jointype] <0.000>: **0**

enter

Enter an option [Close/Open/Join/Width/Fit/Spline/Decurve/Ltype gen/Reverse/Undo]: **C**

enter

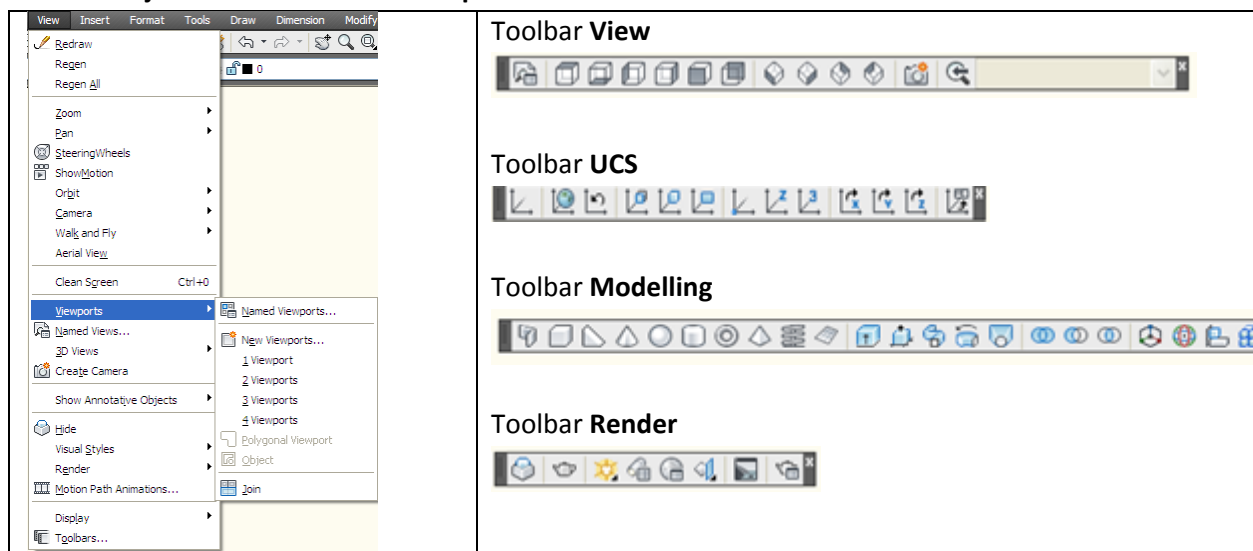
enter

3. Desenho a 3D

A barra “View” permite a visualização do objeto a duas ou três dimensões. Na visualização a 2D pode optar por desenhar na vista de cima (“Top”), na vista de baixo (“Bottom”), na vista da esquerda

("Left"), na vista da direita ("Right"), na vista da frente ("Front") ou na vista de trás ("Back"). Na visualização a 3D poderá optar pela vista "SW isometric", "SE isometric", "NE isometric" ou "NW isometric". Antes de iniciar a elaboração de um objeto a 3D, deve seleccionar, na barra de ferramentas "View", a vista a duas dimensões mais adequada.

Definir as janelas com os diferentes pontos de vista



3.1 A ferramenta "Modelling" permite a elaboração de objetos a três dimensões, com as instruções "Box", "Wedge", "Pyramid", "Sphere", "Cylinder", "Torus", "Pyramid" e "Helix". Após clicar na instrução deverá seguir os passos indicados na linha de comandos.

3.2 Os objetos a 3D podem também ser construídos a partir de desenhos a 2D com as instruções "revolve" ou "extrude". Com esta instrução devem construir-se os objetos a 2D e usar a ferramenta "Edit polyline" para fechar os polígonos.

A instrução "**revolve**" usa-se quando se pretende construir um objeto a 3D a partir da sua projeção e de um eixo de simetria. Devem seguir-se os seguintes passos:

select objects to revolve:

selecione o objecto

Specify axis start point or define axis by [Object/X/Y/Z] <Object>:

Com o rato defina o eixo seleccionando o primeiro ponto que define um segmento de reta

Specify axis endpoint:

Com o rato defina o eixo seleccionando o segundo ponto que define um segmento de reta

Specify angle of revolution or [STart angle] <360>:

360

A instrução "**extrude**" usa-se quando se pretende construir um objeto a 3D a partir da sua projeção e de uma direção perpendicular à da projeção. Devem seguir-se os seguintes passos:

Select objects to extrude:

selecione o objecto

Specify height of extrusion or [Direction/Path/Taper angle] <23.521>:

Indique a altura de extrusão

3.3 UCS.

A ferramenta UCS permite alterar a posição dos eixos coordenados. Selecione a instrução “3 Point”



. Esta tarefa pode ser efetuada de duas formas, seguindo as instruções da linha de comando:

Specify new origin point <0,0,0>:

Selecione a origem dos eixos

Specify point on positive portion of X-axis <1.000,0.000,0.000>:

Selecione um ponto que defina com o anterior o eixos dos xx

Specify point on positive-Y portion of the UCS XY plane <0.000,1.000,0.000>:

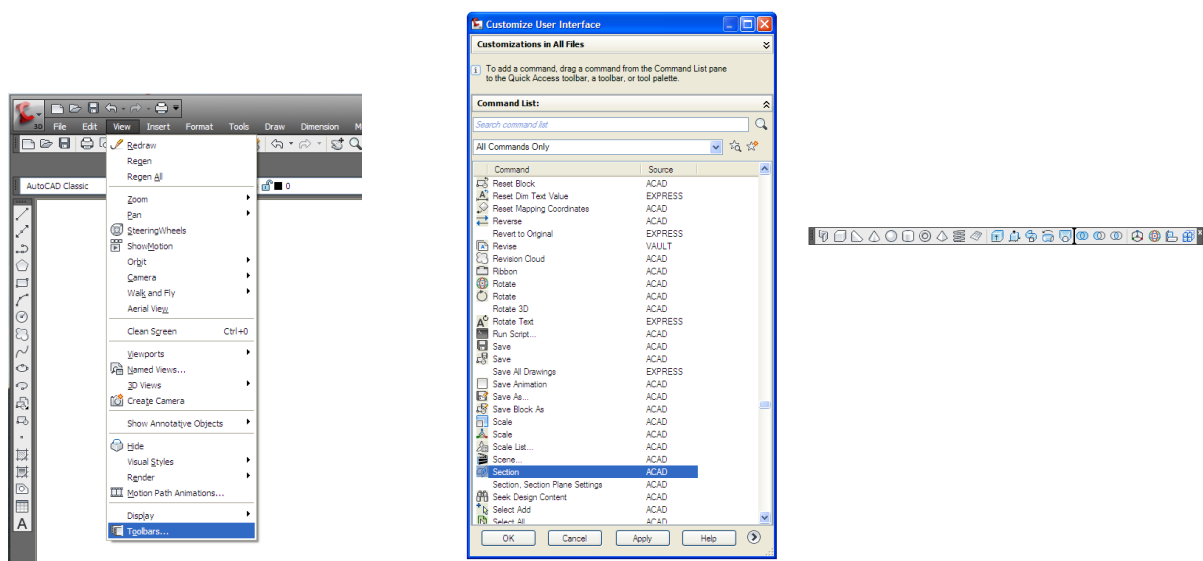
Selecione um ponto que defina com o anterior o eixos dos yy

Os eixos deslocam-se então para o novo referencial.

4. Colocação das ferramentas slice e section na barra Modelling

Os comandos para efetuar os cortes e as secções não se encontram incluídos em nenhuma barra. No entanto, poderá colocar estas duas operações na barra Modelling, procedendo do seguinte modo:

No menu View abrir o menu Toolbars



Abre uma nova janela, “Customizations User in All Files”, na qual se vai seleccionar a instrução “slice”. Arrasta-se para o menu “Modelling”. e faz-se “Apply” na janela “Customizations User in All Files”.

A barra “Modelling” ficará com a instrução de “slice”

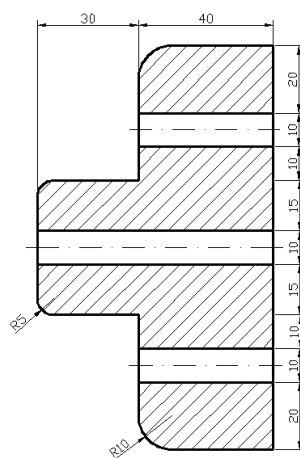


Procede-se do mesmo modo para adicionar a instrução “section”

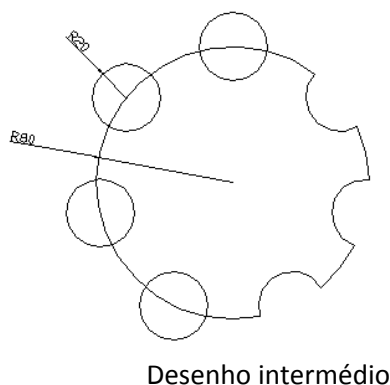
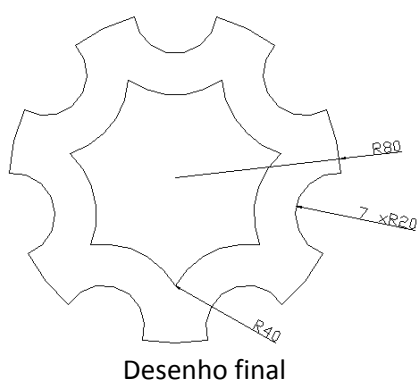


5. Ensino presencial

5.1 Desenhe a seguinte vista cortada. O espaçamento da grelha é 10 unidades.




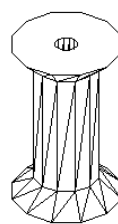
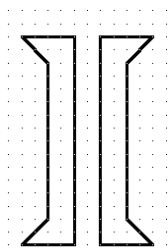
5.2 Para desenhar o seguinte objeto, pode desenhar apenas a parte exterior e utilizar o comando *offset* (25 mm) para obter a parte interior. No entanto para poder fazer isso, primeiro precisa de transformá-lo numa poli-linha.





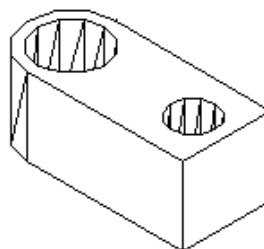
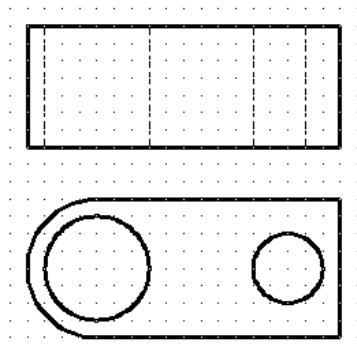
5.3 Desenhe os seguintes objetos a 3 dimensões. Faça os cortes e as secções segundo a vertical e a horizontal, que achar mais conveniente, selecionando o plano mais adequado.






Nota: de modo a visualizar melhor o objeto a 3 dimensões, após a sua construção aplique o comando **HIDE**.

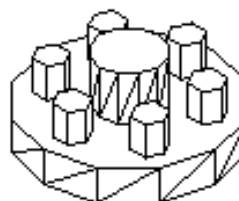
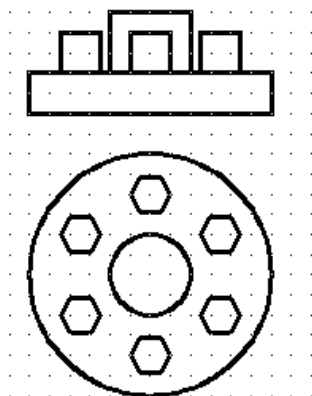
5.3.1 Carrinho de linhas. A secção do objeto, passando pelo eixo central está apresentada na figura seguinte (o espaçamento da grelha é 10 unidades). Use o comando  **REVOLVE**.








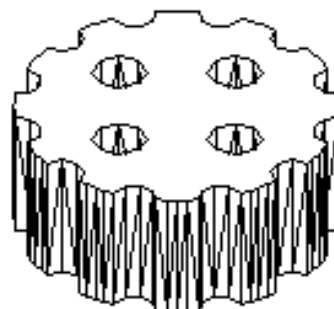
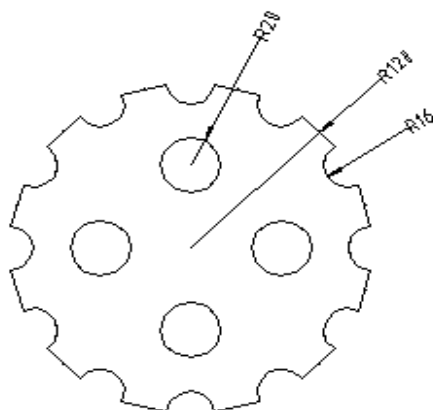
5.3.2 Desenhe a peça seguinte de acordo com as indicações fornecidas (o espaçamento da grelha é 10 unidades). Transforme-o numa placa com 50 de altura utilizando **EXTRUDE**, . Desenhe dois cilindros com 60 de altura na placa. Em seguida subtraia os cilindros da placa .



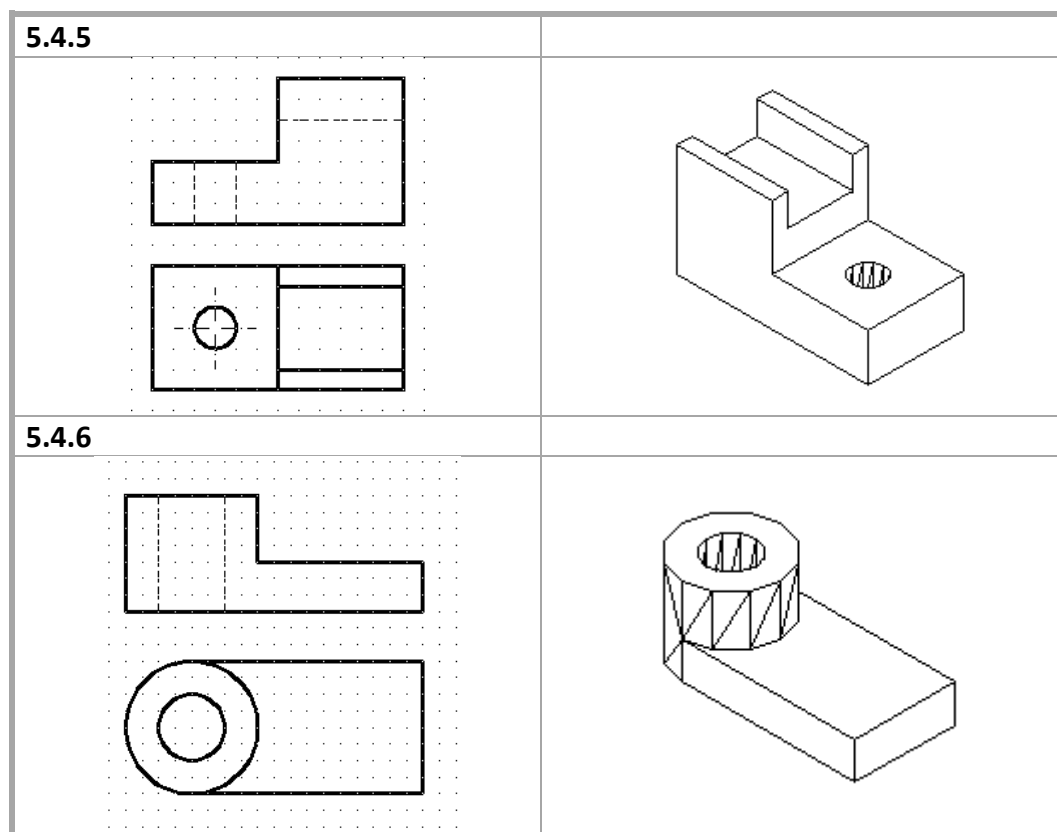
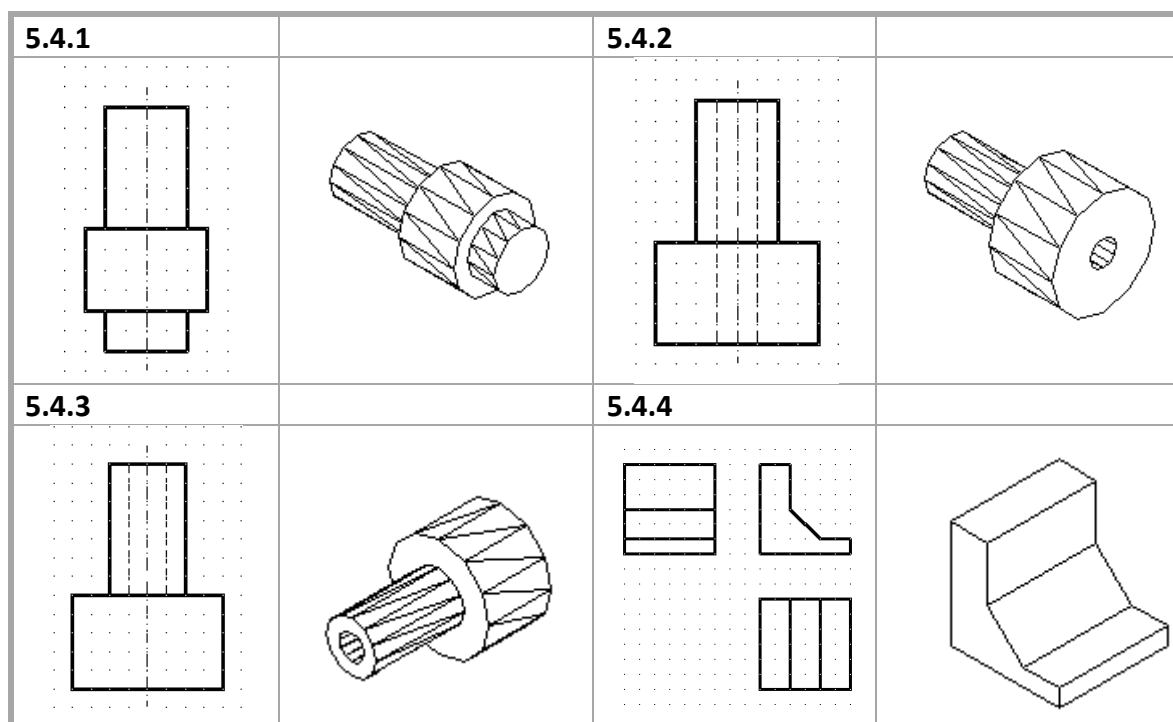
5.3.3 Desenhe este objeto utilizando os seguintes comandos:     . Considere que o diâmetro dos hexágonos é 10 mm, a altura da base 20 mm, a altura dos hexágonos 35 mm e a altura do cilindro central 40 mm.



5.3.4 Desenhe a peça seguinte a 3D, utilizando os comandos indicados:     . A peça tem 50 mm de altura.

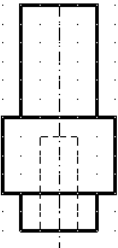
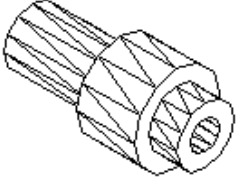
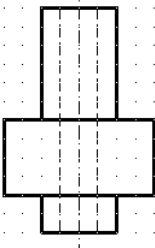
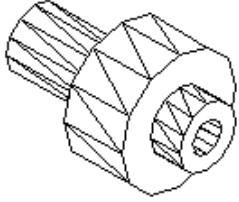
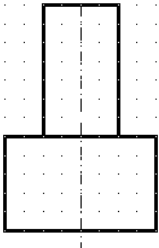
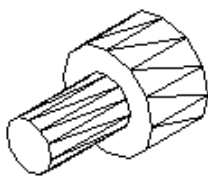
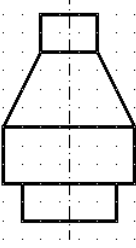
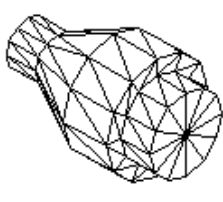
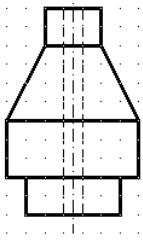
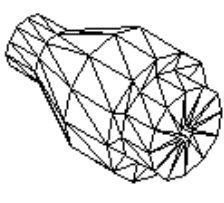
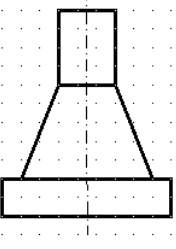
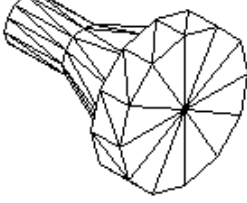
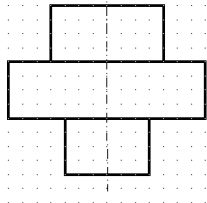
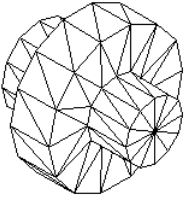
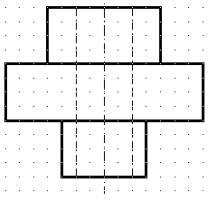
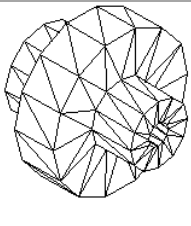
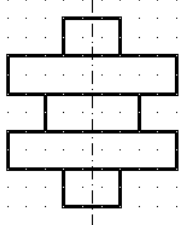
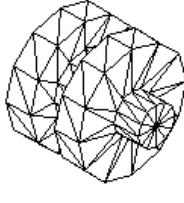
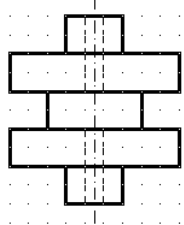
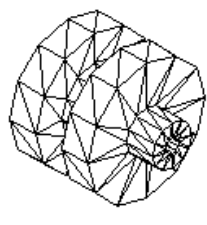


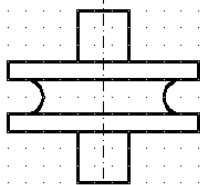
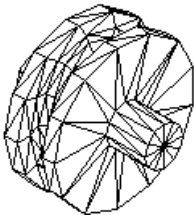
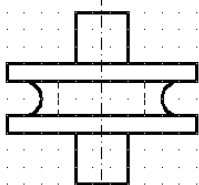
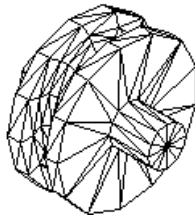
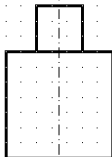
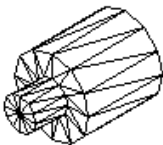
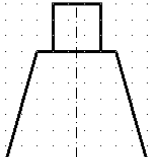
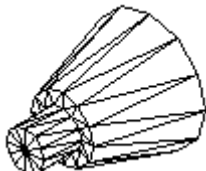
5.4 Desenhe as peças a 3D (o espaçamento da grelha é 10 unidades). Faça os cortes e as secções, que achar mais conveniente, seleccionando o plano mais adequado.

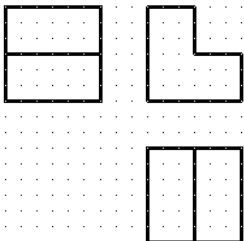
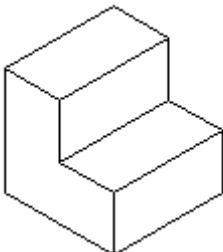
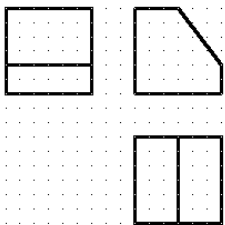
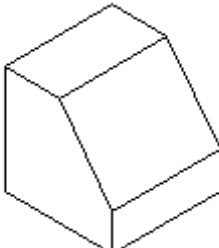
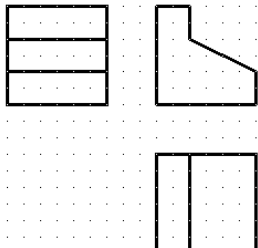
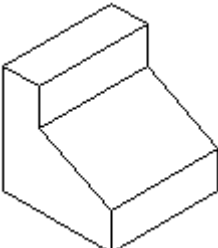


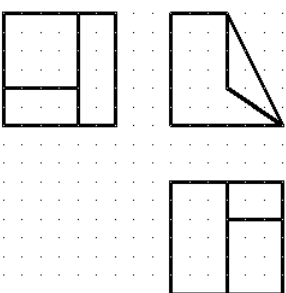
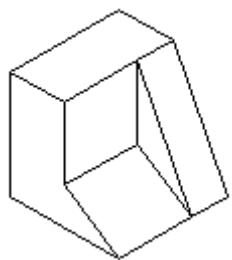
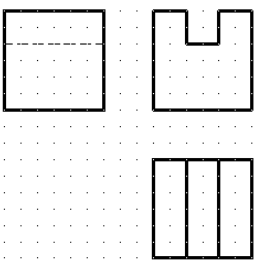
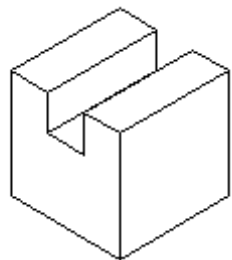
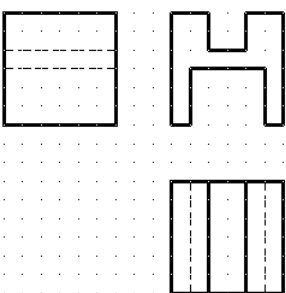
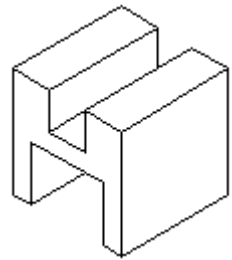
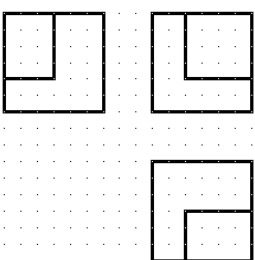
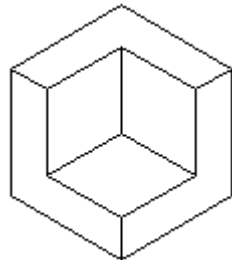
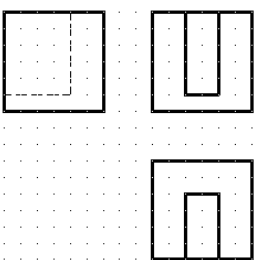
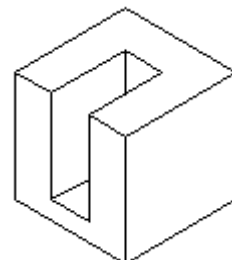
6. Trabalho não presencial

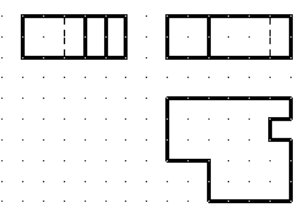
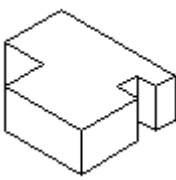
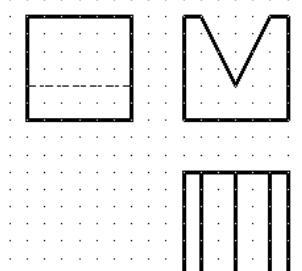
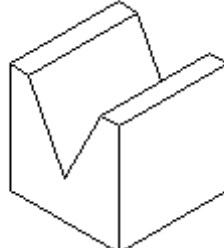
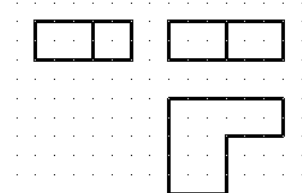
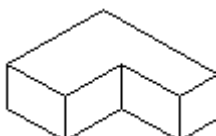
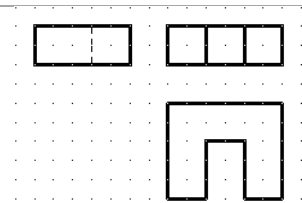
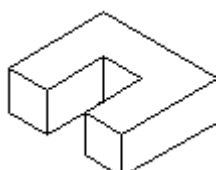
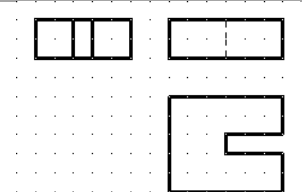
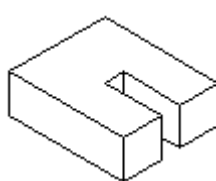
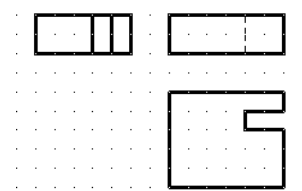
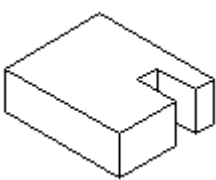
Desenhe as peças a 3D (o espaçamento da grelha é 10 unidades). Faça os cortes e as secções, que achar mais conveniente, seleccionando o plano mais adequado.

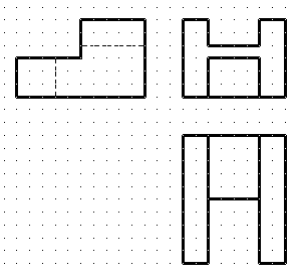
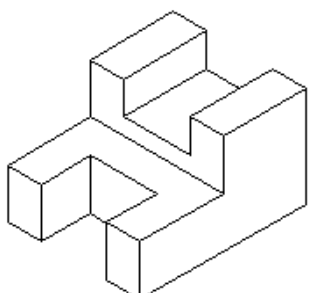
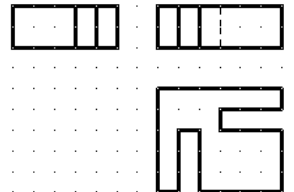
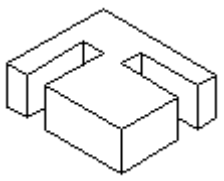
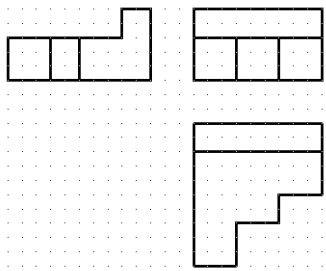
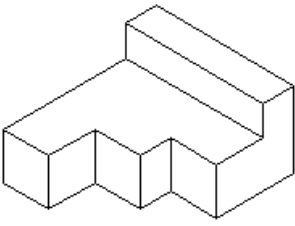
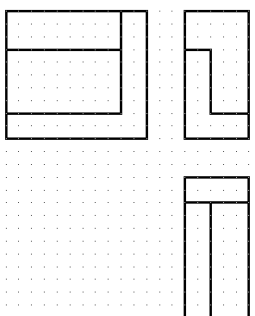
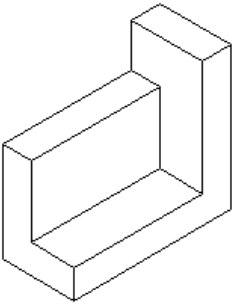
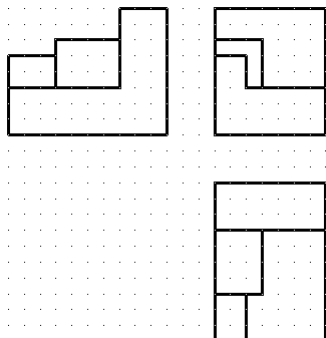
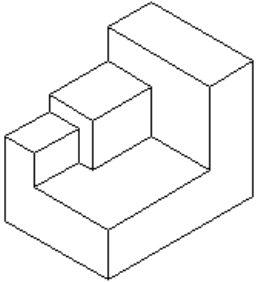
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6.9 		6.10 	

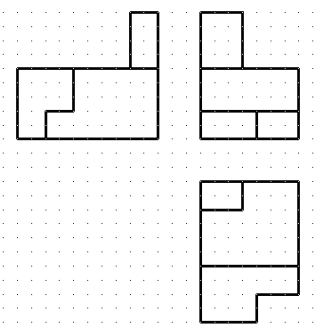
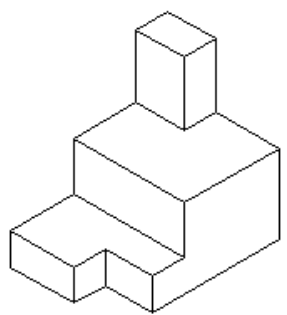
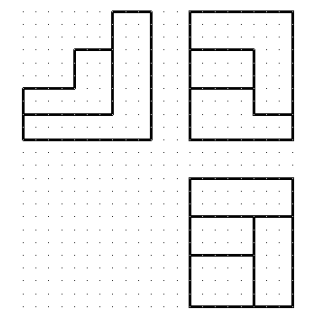
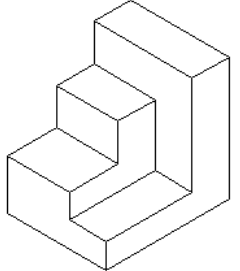
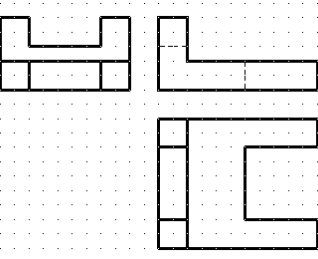
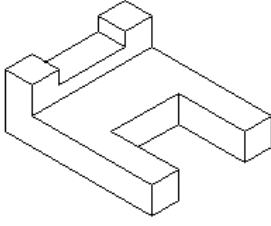
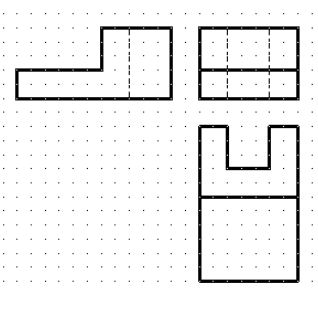
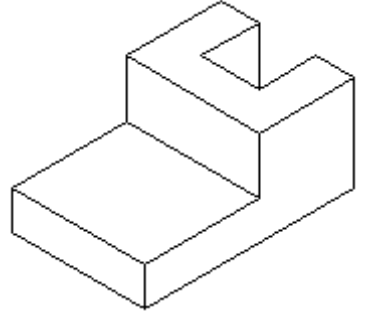
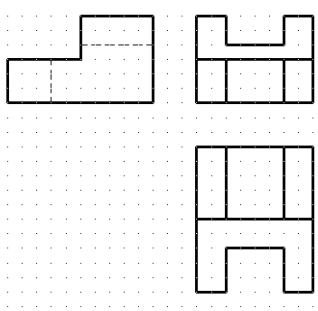
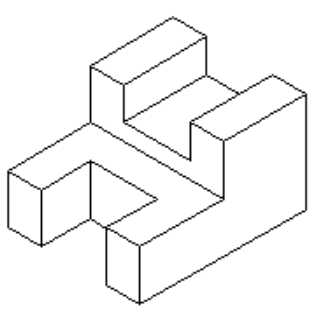
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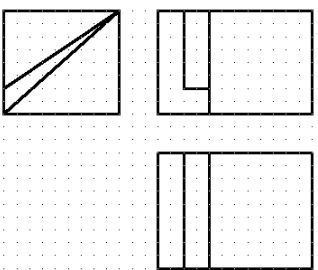
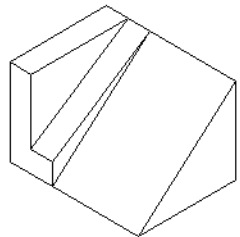
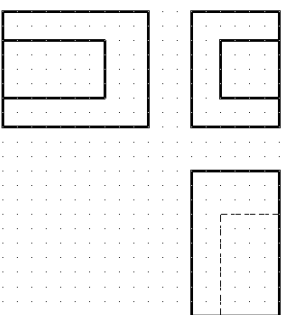
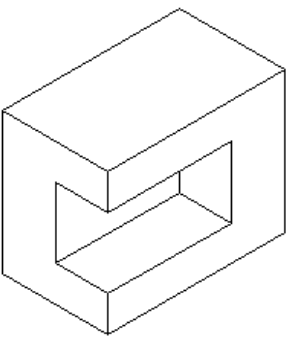
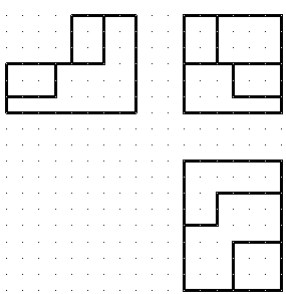
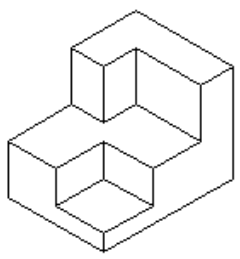
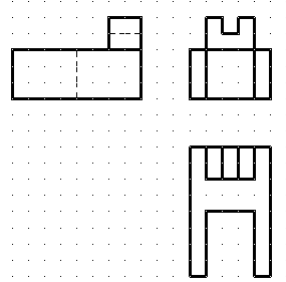
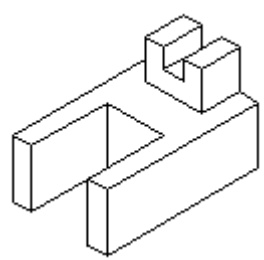
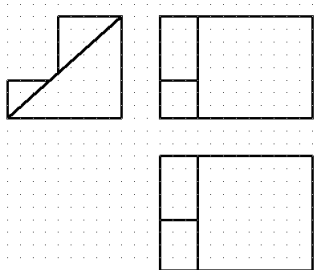
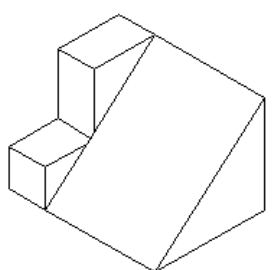
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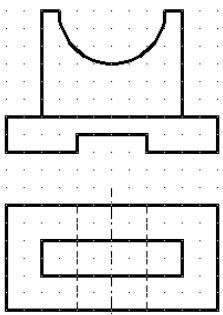
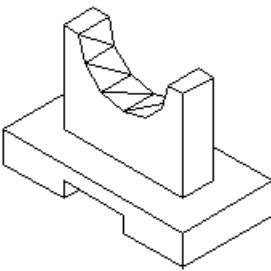
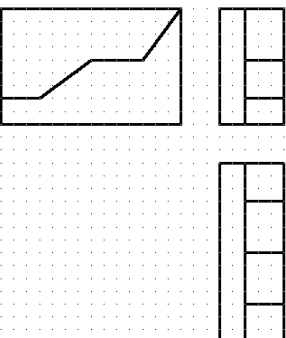
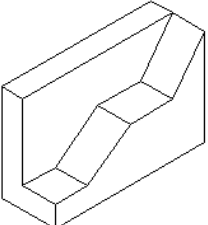
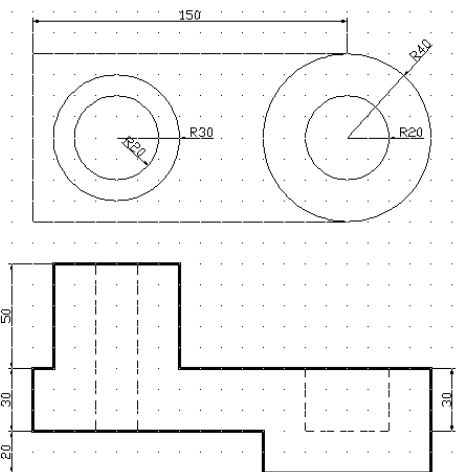
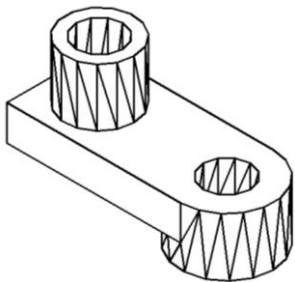
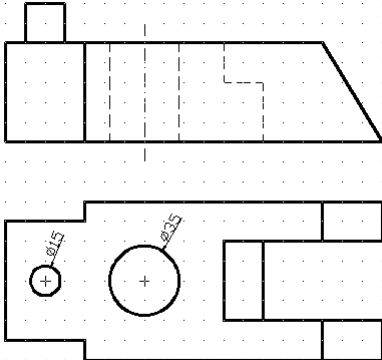
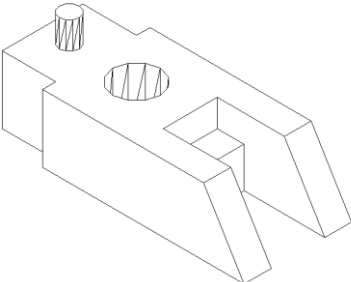
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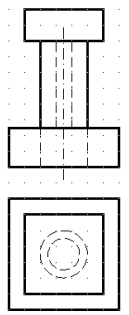
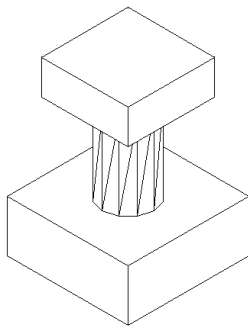
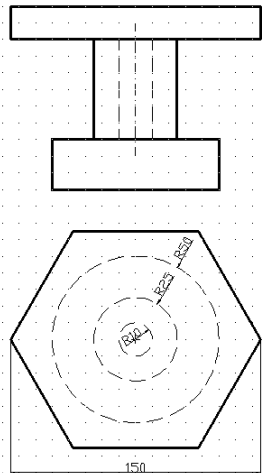
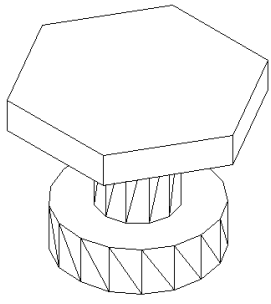
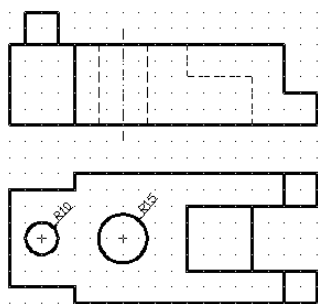
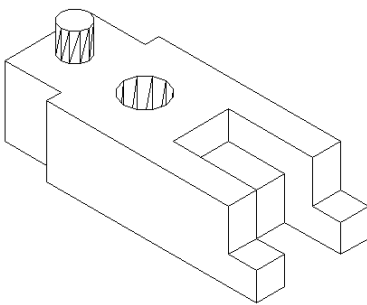
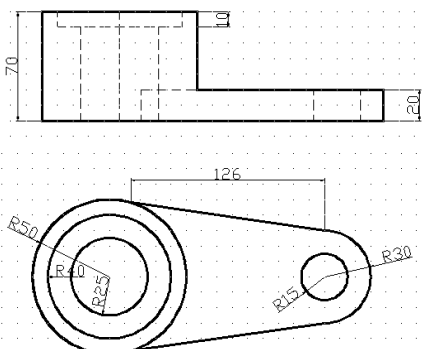
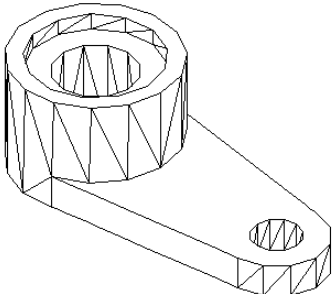
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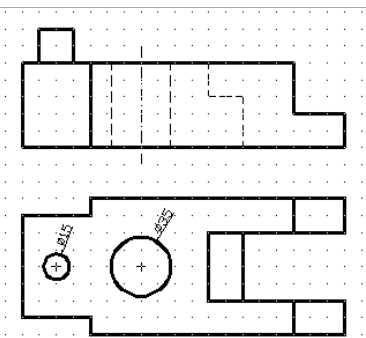
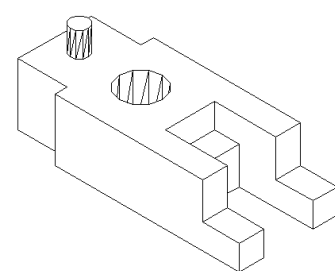
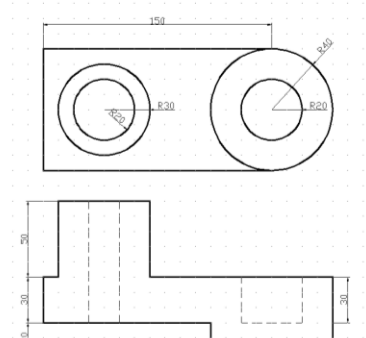
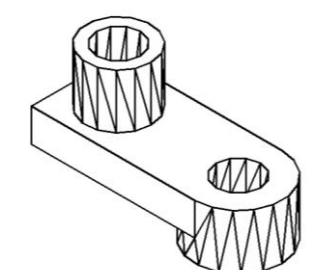
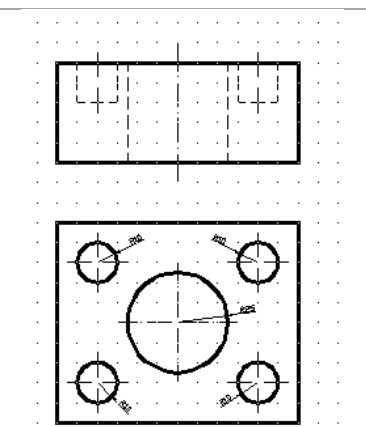
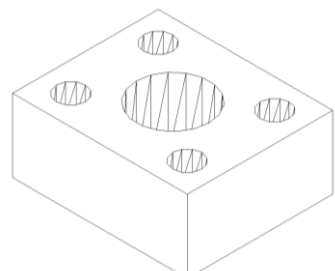
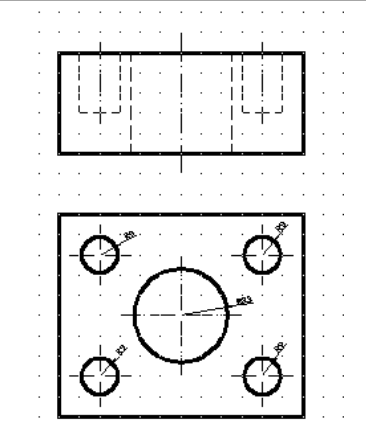
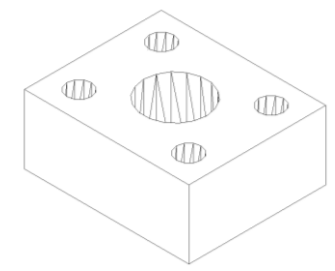
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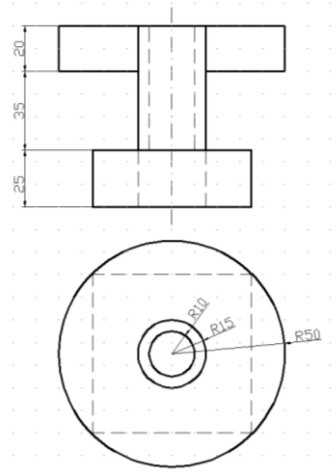
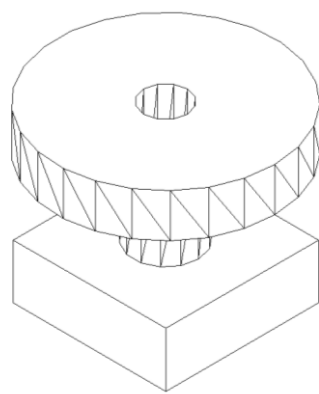
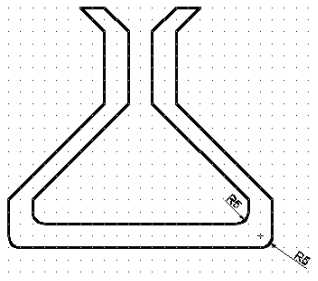
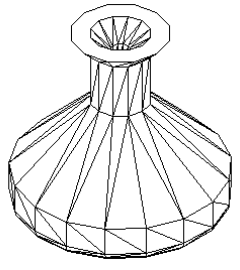
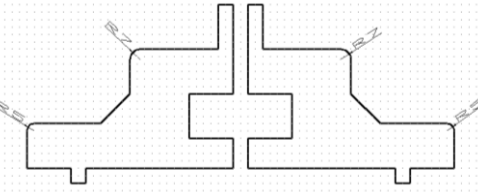

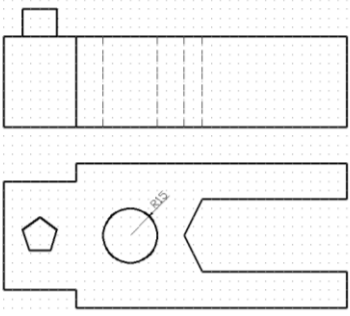
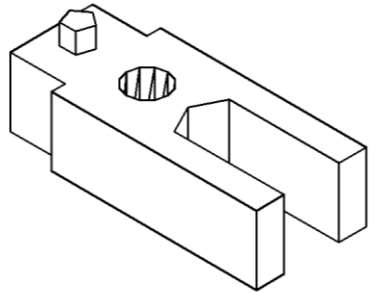
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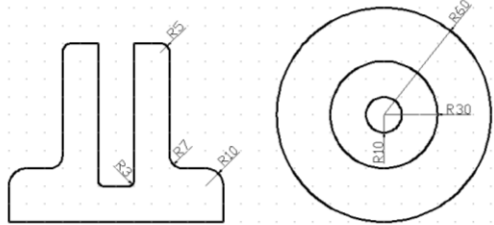
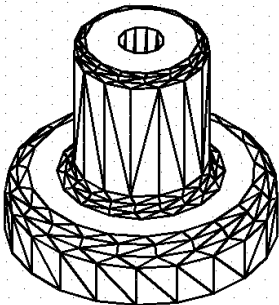
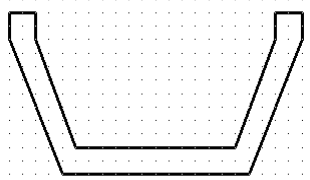
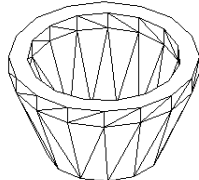
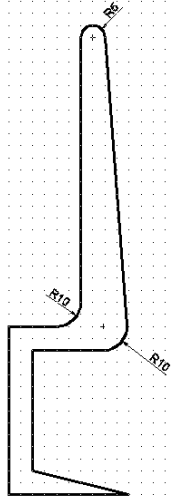

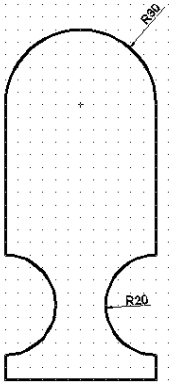
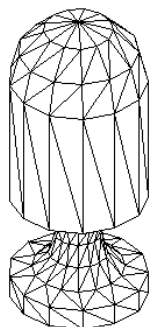
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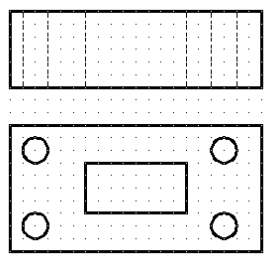
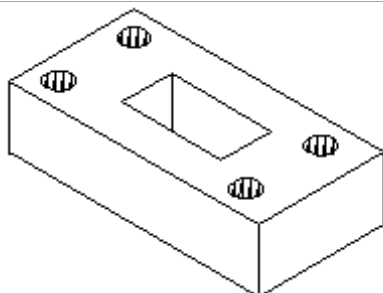
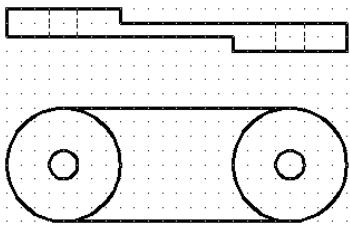
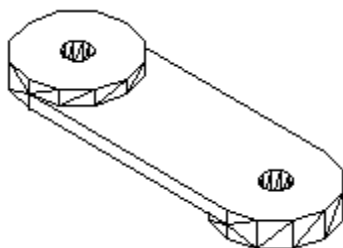
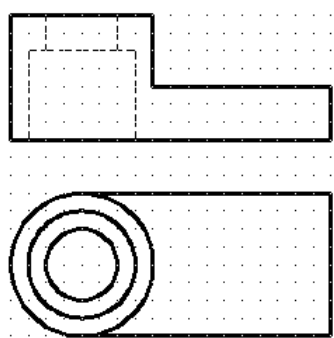
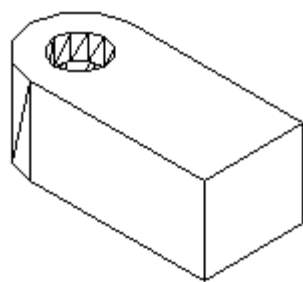
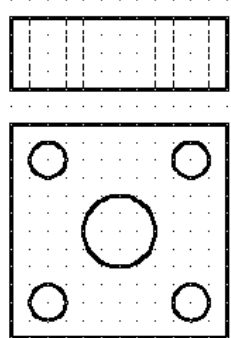
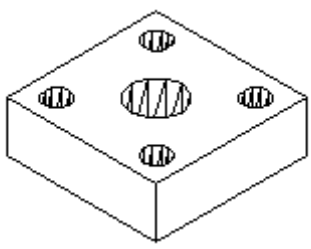
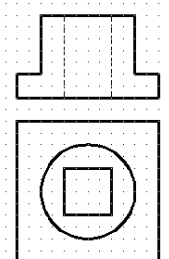
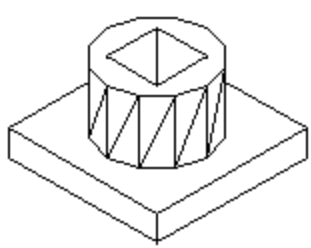
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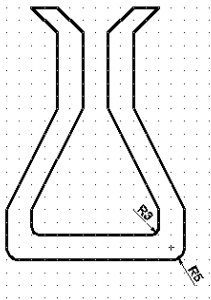
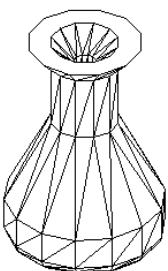
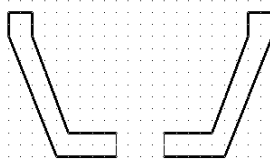
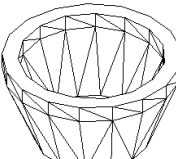
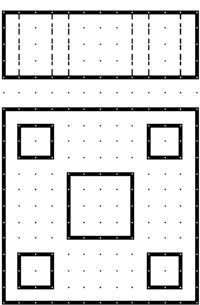
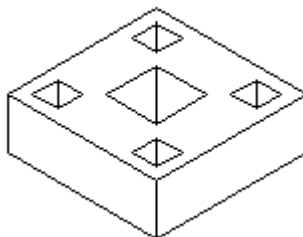
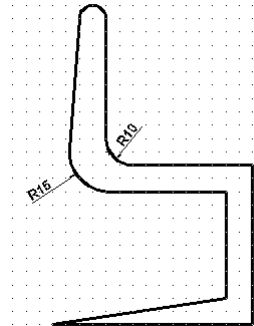
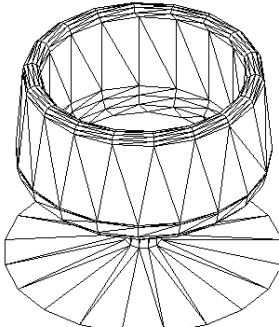
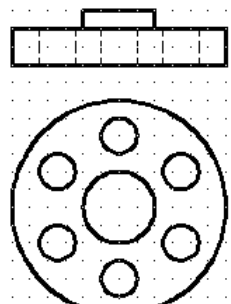
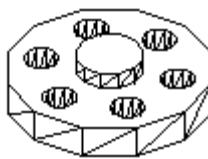
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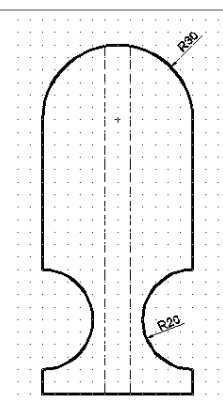
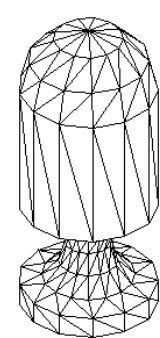
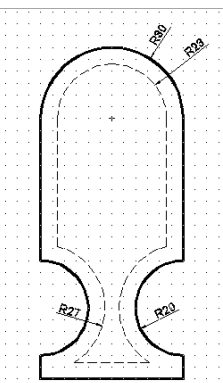
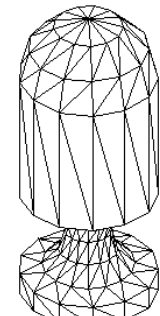
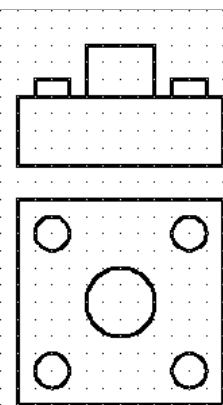
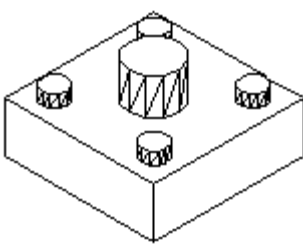
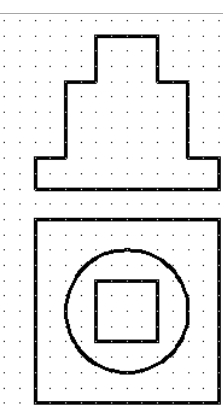
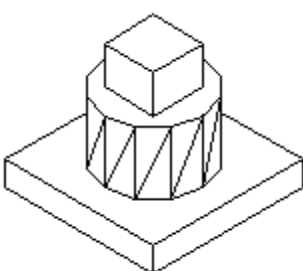
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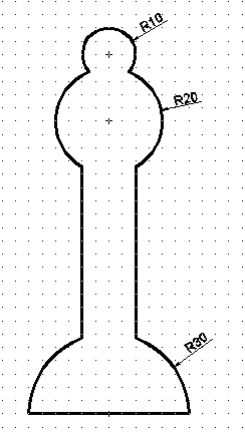
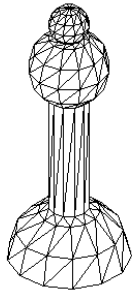
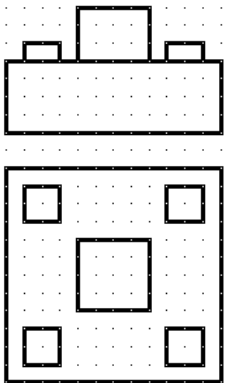
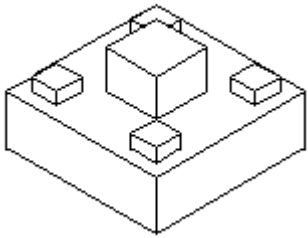
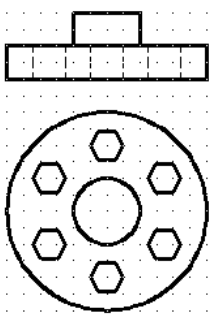
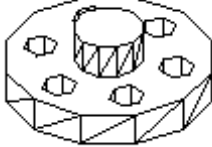
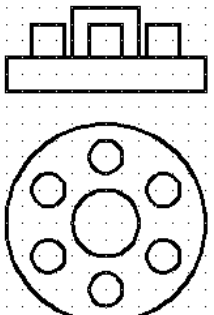
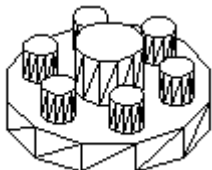
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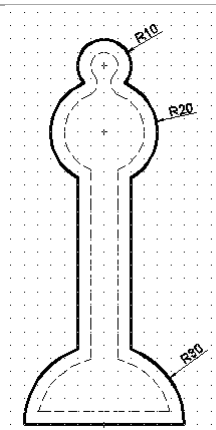
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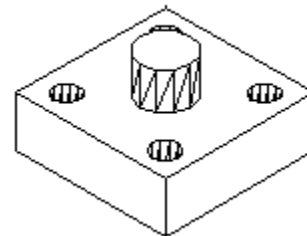
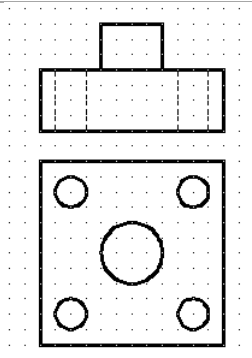
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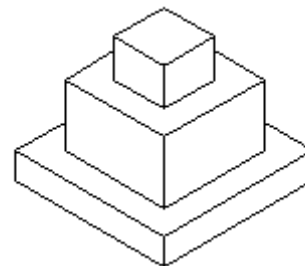
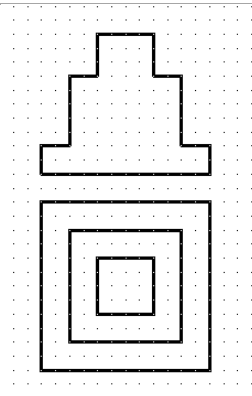
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6.83



6.84



6.85

